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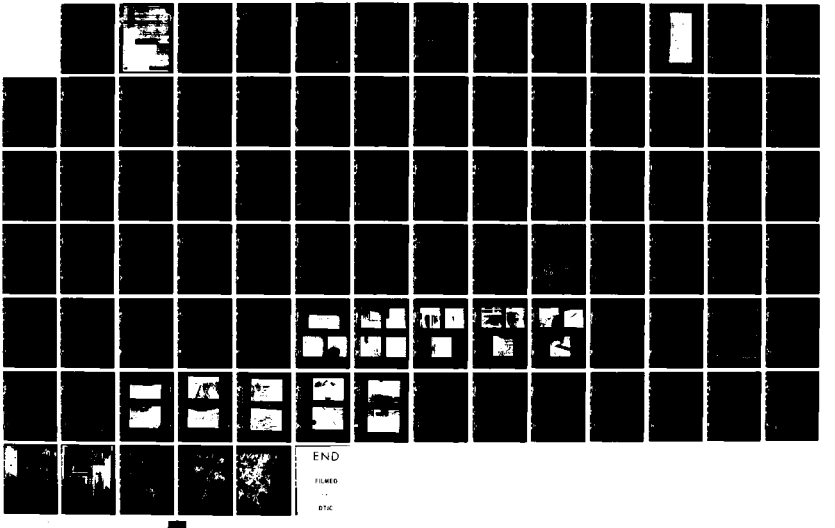

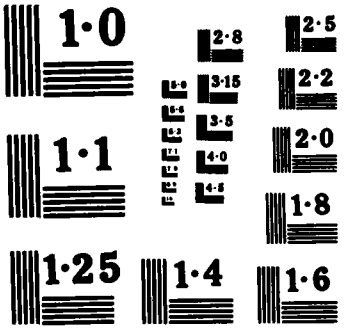
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FARMINGTON

CT.

GOODWIN DAM

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,
Farmington River Basin
Hartland, Connecticut

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Goodwin Dam is an earth embankment and rock embankment with an earth core that is 800 feet long and 125 feet high. It has an emergency spillway, channel gate house and diverstion tunnel. The dam and its appurtenant structures are in good condition. The dam will pass the PMF without overtopping the dam.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF

NEDED

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

NOV 30 1978

Dear Governor Grasso:

I am forwarding to you a copy of the Goodwin Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, the Metropolitan District of Hartford County, 555 Main St., Hartford, Connecticut 06100.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

GOODWIN DAM

CT 00541

FARMINGTON RIVER BASIN
HARTLAND, CONNECTICUT

PHASE 1 INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

Identification Number:	CT 00541
Name:	Goodwin Dam
Town:	Hartland
County and State:	Hartford County, Connecticut
Stream:	West Branch of the Farmington River
Date of Inspection:	June 1, 1978

BRIEF ASSESSMENT

The Goodwin Dam is an earth and rock embankment with an earth core that is 800 feet long and 125 feet high. It has an emergency spillway, channel, gate house and diversion tunnel. The dam and its appurtenant structures are in good condition.

The dam will pass the Probable Maximum Flood (recommended Spillway Design Flood) without overtopping the dam.

Some recommended measures, as described in Section 7 to be undertaken by the owner, should include the establishment of metering points for seepage measurement and periodic inspections of the dam. It is not urgent to implement these recommendations. However, it is recommended that the owner implement them within two to three years after receipt of this Phase I Inspection Report.

Joseph F. Merluzzo
Connecticut P.E. #7639
Project Manager

Richard F. Lyon
Connecticut P.E. #8443
Project Engineer

This Phase I Inspection Report on Goodwin Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Charles G. Tiersch

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

Fred J. Ravens Jr

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

Saul Cooper

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface evaluations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify the need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present conditon of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and varity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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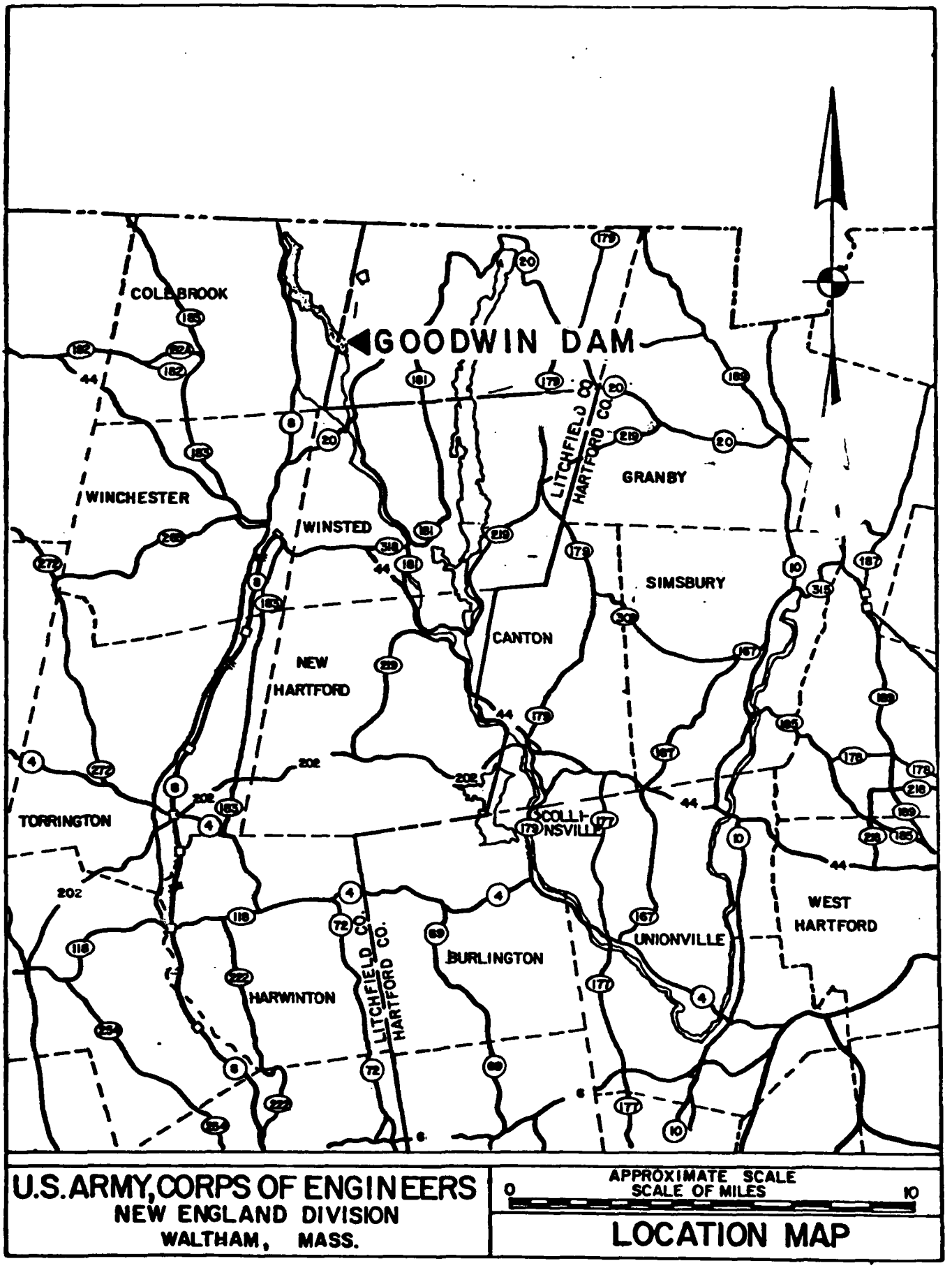
APPENDIX MATERIALS

OVERVIEW PHOTO - GOODWIN DAM (HOGBACK)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WINCHESTER
WINSTED
NEW HARTFORD
TORRINGTON
CANTON
GRANBY
SIMSBURY
COLLINSVILLE
UNIONVILLE
WEST HARTFORD
BURLINGTON
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LOCATION MAP

PHASE I INSPECTION REPORT

GOODWIN DAM CT 00541

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Storch Engineers has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed was issued to Storch Engineers under a letter of May 3, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0000 has been assigned by the Corps of Engineers for this work.

b. Purpose -

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly, effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

The Goodwin Dam is one of 18 dams owned and operated by the Metropolitan District of Hartford County, Connecticut. The structure is an earth and rock fill embankment with an earth core. The dam is 800 feet long and 125 feet high (Plate 1). It has an emergency spillway and channel, a gate house and diversion tunnel. The facility impounds the West Branch Reservoir and serves as compensating water for riparian owners. The reservoir will also be used as water supply when the demand in the Hartford area warrants it. This will be accomplished by connecting it to the Barkhamsted Reservoir by a tunnel.

The dam is located in the Town of Hartland, Hartford County, Connecticut (See Location Map) and is approximately 22 miles northwest of Hartford, Connecticut. The dam is also located on the West Branch of the Farmington River, in the Farmington River Basin.

The size classification of the dam is large (125 feet high and 7,140 acre feet storage) and the hazard classification is high per the criteria set forth in the Recommended

Guidelines for Safety Inspection of Dams by the Corps of Engineers. The immediate downstream area that will be affected by the dam's failure as shown in Appendix D, Plates 6, 7 and 8 includes portions of Riverton, New Hartford, Collinsville and Unionville as well as numerous homes and farms along the river banks.

The Goodwin Dam was designed by the Engineering Section of the Metropolitan District under the direction of Warren Gentner, Chief Engineer. Several consultants such as Karl Terzaghi, Charles Berkey, Leo Casagrande, David Wiggin and Karl Kennison were retained as experts for the design. Model tests of the spillway and channel were performed in 1954 by the Alden Hydraulic Laboratory of the Worcestor Polytechnic Institute (Appendix B, Page B-1, Reference 2).

The dam was constructed between the years 1955 and 1960 by White Oak Excavators, Plainville, Connecticut.

There is a regular staff of maintenance personnel available. The items that are scheduled for regular maintenance include the cutting of grass on the embankment of the dam, servicing of the gate house equipment and inspection of the diversion tunnel.

The person in charge of day to day operation of the dam is Irv Hart, MDC Supply Division Headquarters, Beach Rock Road, Barkhamsted, Connecticut; Telephone No.: 379-0938.

1.3 Pertinent Data

a. Drainage Area - The 120.0 square mile drainage area that contributes to the West Branch Reservoir is a fairly broad watershed. The terrain is hilly and forested with some development. Of the 120.0 square mile drainage area, 118 square miles is controlled by the Colebrook Flood Control Dam which was completed in 1970.

b. Discharge at Damsite - Maximum known flood at the site which occurred prior to the dam's construction is 35,400 cfs, (August, 1955). Maximum Pond Elevation to date was 641.75 feet MSL and the discharge was 5,000 cfs.

(1) Outlet works (conduits) size:

2-24" and Invert Elevation 540.5

2-30" and Invert Elevation 540.0

2-36" and Invert Elevation 539.4.

(2) Maximum known flood at damsite 35,400 cfs.

(3) Ungated spillway capacity at maximum pool elevation: 92,000 cfs at 650.0 feet MSL.

(4) Gated spillway capacity at pool elevation N/A cfs at N/A elevation.

(5) Gated spillway capcity at maximum pool elevation N/A cfs at N/A elevation.

(6) Total spillway capacity at maximum pool elevation: 92,000 cfs at 650.0 feet MSL.

c. Elevation (Feet above MSL)

(1) Top Dam: 659.0

(2) Maximum pool-design surcharge (MDC): 650.0

(3) Full flood-control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest: 641.0

(6) Upstream portal invert diversion tunnel: 537.46

(7) Streambed at centerline of dam: 524.0

(8) Maximum tailwater: 562.0

d. Reservoir - Up to Colebrook Dam

(1) Length of maximum pool: 7,500 feet

(2) Length of recreation pool: N/A

(3) Length of flood-control pool: N/A

e. Storage: (Acre-Feet) - Up to Colebrook Dam

(1) Recreation pool: N/A

(2) Flood-control pool: N/A

(3) Design surcharge (MDC): 7,140±

(4) Top of dam: 8,900±

f. Reservoir Surface (Acres) - Up to Colebrook Dam

(1) Top of dam: 220.0±

(2) Maximum pool: 220.0±

(3) Flood-control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest: 220.0±

g. Dam

(1) Type: Earth and rockfill embankment with earth core

(2) Length: 800 feet ±

(3) Height: 125 feet ±

(4) Top width: 65 feet ±

(5) Side Slopes: Varies; U/S - 1:2.5 to 1:22
D/S - 1:2.5 to 1:2.4
(See Cross Section, Appendix B, Plate 2)

(6) Zoning: See cross section, Appendix B, Plate 2.

(7) Impervious core: Earth

(8) Cutoff: Not less than four feet

(9) Grout curtain: 25 to 30 feet

(10) Other: N/A

h. Diversion and Regulating Tunnel

(1) Type: Concrete

(2) Length: 420 feet ±

(3) Closure: N/A

(4) Access: Upper gate house

(5) Regulating Facilities: Electrically operated gates

i. Spillway

(1) Type: Fixed weir (concrete)

(2) Length of weir: 900 feet

(3) Crest elevation: 641 feet

(4) Gates: None

(5) U/S Channel: Earth approach underwater - five feet

(6) D/S Channel: 1,700 feet rock channel

(7) General: N/A

j. Regulating Outlets

Regulating outlets consist of two, 24 inch; two, 30 inch and two, 36 inch diameter pipes. There is also provisions for a future connection to Barkhamsted Reservoir.

(1) Invert: 540.6, 540.0 and 539.4

(2) Size: two, 24 inch; two, 30 inch respectively

(3) Description: steel pipes

(4) Control mechanism: Electrically operated gates

(5) Other: N/A

SECTION 2 - ENGINEERING DATA

2.1 Design

The dam was designed by the Metropolitan District in conjunction with several well-known experts in the fields of geology, soils and hydraulics. In addition to the expertise, provided by these consultants, there have been a number of studies performed before, during and after the completion of construction in 1960.

During the design phase, the Metropolitan District conducted several studies concerning virtually every structural element of this dam. Dr. K. Terzaghi considered various sections for this design including a concrete core wall. In his report of April 2, 1952, (Appendix B, Page B-1, Reference 4) he pointed out that it would be a waste of money to provide the dam with a core wall unless this wall is designed in such a manner that it would remain intact in spite of the deflections which will be produced by the water pressure on its upstream face. The different designs and checks of the spillway and diversion tunnel for this dam was supplemented with a dam model test conducted by the Alden Hydraulic Laboratory at Worcester Polytechnic Institute (Appendix B, Page B-1, Reference 2) and reports by various other prominent consultants.

2.2 Construction

The dam was constructed between the years 1955 to 1960 by White Oak Excavators Construction, Plainville, Connecticut. It was constructed using an upstream and downstream cofferdam with a diversion tunnel sized to handle the August, 1955 flood. Appendix B, Plate Nos. 1-4 show the general features of the construction.

It was noted from conversations with personnel of the Metropolitan District that there were no unusual problems encountered during construction.

2.3 Operation

The diversion tunnel is operated only when it provides for downstream water supply. A water level indicator is monitored weekly in the gate house. Regulation of the water flow in the gate house is through stop logs and sluice gates.

The method of operation is basically manual requiring personnel attendance as needed to accommodate changing conditions or flow regulation. Manual operations are assisted by means of motor operators on the valves and an electrically operated bridge crane.

2.4 Evaluation

a. Availability - Design, construction and operation information is readily available. A list of references used to study the dam is contained in Appendix B of this report.

b. Adequacy - The information made available for this inspection along with the visual inspection, past performance history and hydrologic and hydraulic assumptions were more than adequate to access the condition of the dam.

c. Validity - The validity of the information is not questionable and the history of the dam seems to bear this out.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General - The visual inspection for this dam was conducted on June 1, 1978 by members of the Engineering Staff of Storch Engineers and with the help of Peter Revill of the Metropolitan District. A copy of the visual inspection check list is contained in Appendix A of this report.

The following procedure was used:

1. The top and side slopes of the dam, appurtenant structures were inspected.
2. The banks in the downstream area were visually surveyed.
3. The upstream surfaces of the dam, outside of gate house and weir, as well as the banks of a reservoir were inspected.
4. The dam crest was visually surveyed.
5. Areas were checked for evidence of leaking, leaching or damage.
6. The dam and its appurtenant structures, as well as local places that had cracks, seepage and leaks were photographed.

7. Seepage discharges at the cracks, joints and drains were measured.

Before the inspection, the design, construction, operation and maintenance documentation and results of repair from prior inspections were compiled and studied. A compact sketch of the main structures was used for orientation during the period of inspection (Appendix B, Plate 1).

In general, the overall appearance and condition of the dam and appurtenant structures is good.

b. Dam - The downstream face of the dam was inspected for evidence of seepage on the surface. The surface appeared dry and the infra-red photographs taken to check for moisture showed no seepage. The underdrains for the seepage localization of the body of the dam exit at a point in the bed of the stream and could not be located.

The overview photo shows that the grass of the embankment is well maintained and free of any irregularities or bulges. In the area of the gate house, a parapet wall settlement of 4 to 5 inches was observed and appears to be normal for this location, however, there appears to be an increase from the Metropolitan District inspection results of 1973 when the settlements were 1 to 3 inches (Appendix B, Page B-1, Reference 6).

The visual inspection of the upstream riprap indicated it to be in excellent condition with no shifts or movements observed.

c. Appurtenant Structures - The spillway is a concrete weir on top of a ledge channel (Appendix C, Page II-2) and is in good condition. The spillway channel condition is excellent and there are no evidences of loose rock or slippage of any ledge.

The inspection of the gate house and diversion tunnel showed that there is some minor leakage and leaching along the construction joints of the interior walls. At the time of the inspection, one, 24 inch diameter gate was partially open so minimum flow could be maintained. The resulting mositure in the tunnel was evident and at two construction joints and one vertical crack (Appendix C, Page II-4) flows were visible, approximately 4 to 6 gallons/minute from the joints and 2 gallons/minute from the crack. This seepage caused leaching of lime from the concrete.

At the end of the diversion tunnel there are two seepage pipes which penetrate the walls (Appendix C, Page II-5). The flow from the east drain is approximately 5 to 6 gallons/minute and the west drain approximately 0.05 to 0.1 gallon/minute. Also the seepage from the west drainage

pipe is accompanied by rusty, brown material which deposits on the surface of the tunnel wall.

In general, the remaining concrete of the tunnel is in good condition. A dehumidification system was installed to cut down the moisture in the gate house structure. The layout for the gate house is simple and as a result is fairly maintenance free.

d. Reservoir Area - An inspection of the upstream reservoir area showed that the riprap is in satisfactory condition with no evidence of shifting or repair. The area immediately upstream of the dam embankment seems to be in very natural state with no visible signs of erosion, sloughing or distress.

e. Downstream Channel - The spillway and downstream channel are cut into ledge rock (Appendix C, II-2 and II-3) and are in good condition. There is no visible erosion or sloughing of the floor or walls.

3.2 Evaluation

The visual inspection of this facility did not reveal any apparent areas of distress. The general condition of the dam and its appurtenant structures is good.

The seepage flows from the body of the dam could not be monitored because the underdrains were in the river bed and apparently inaccessible. The normal flow of water through the dam appears negligble. Surface cracks, embankment bulges, piping or boils were not observed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The responsibility for maintenance is with the Metropolitan District Commission. The maintenance staff is headquartered in a building located approximately 1/2 mile west of the dam. These personnel perform the necessary work needed to patrol the area for trespassers, mow the grass slopes and maintain the equipment in the gate house.

There is no written standard operating procedure for maintenance or emergency operating procedures.

4.2 Maintenance of the Dam

The maintenance of the dam is very consistent for the items mentioned above. The maintenance needed is minimal because of the capacity and type of construction of the spillway.

4.3 Maintenance of Operating Facilities

The overall maintenance of all the mechanical and electrical components of the Goodwin Dam facilities which could be observed appeared to be good with some notable exceptions. A "punch list" of these deficiencies will be provided to the Metropolitan District to use as they see fit.

Ventilation and high humidity appears to be an inherent problem in the lower level of the gate house and in the diversion tunnel. As a result, the dampness has corroded some of the miscellaneous steel at the lower levels. A dehumidification system was installed in the stairwell of the gate house to minimize the dampness. Electric power is used to operate the gates in the diversion tunnel, domestic lights and the heat and dehumidification system in the gate house.

4.4 Description of Warning System

There is no warning system in effect.

4.5 Evaluation

The maintenace or lack of maintenance of the diversion tunnel and controls will not jeopardize the safety of the dam since the capacity of the spillway precludes the hydraulic need for the diversion tunnel. The existence of the diversion tunnel is necessary only for the purpose of maintaining a minimum flow downstream during a dry spell or at other times as stipulated in Section 6.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data - The 900 foot long spillway and multiple sluice gates in the diversion tunnel are the only means of transmitting water past the dam. As stated in Section 2, a model test was conducted on the spillway in 1954. This test gave important data to the designers concerning the characteristics of the spillway and determined its behavior during the design flood. A review of the calculations by the MDC indicates that the spillway is capable of passing the PMF. The design discharge for the spillway is 92,000 cfs.

b. Experience Data - The maximum flood to date at the site was the flood of August, 1955. During this flood, a flow of 35,400 cfs was experienced, however, since the dam was constructed, the maximum discharge was 5,000 cfs at elevation 541.75.

c. Visual Observations - The spillway and channel at the time of the inspection were in good condition. The gates are all in good condition as well as the diversion tunnel and outlet channel. The sluice gates in the diversion tunnel can be fully opened in the event of an emergency.

d. Overtopping Potential - The probable maximum flood would flow over the spillway (See Appendix B) at a depth of 9.0 feet, which is the design depth. This flow over the spillway does not take into account flow through the sluice gates.

The U.S. Army Corps of Engineers have performed a detailed hydrologic study on the Farmington River showing the maximum discharge from the Colebrook Dam to be 92,000 cfs.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - During the course of the inspection, there were few items that were not functioning properly. A complete account of the visual inspection is contained in Section 3 and the post-construction changes are discussed in paragraph c below.

b. Design and Construction Data - The stability analysis of the embankment was accomplished for the entire dam against a headwater pressure and horizontal shear in upstream and downstream dam portions after complete drawdown (Appendix B, Page B-1, Reference 3). For the downstream fill of the dam, the shearing was defined with a varying height of seepage line. The properties of the dam fill was established on basis of the field tests (Reference 4, K. Terzghi's and L. Casagrande's reports) and from Merriman "American Civil Engineering Handbook", 1925. The computations were based on the methods used in "Engineering for Dams", 1947.

The computations showed that with all the combinations of loads for the accepted design configuration of the earth core, the factor of safety for all the combinations of the loads vary as follows:

1. For the entire dam, from 7.0 to 1.0 to 7.4 to 1.0,

2. For the downstream portion (Elevation 650) at point of maximum shear, 2.1 to 1.0 to 2.48 to 1.0,

3. For the upstream portion (100% drawdown from Elevation 650) at point of maximum shear, 1.55 to 1.0 to 2.5 to 1.0.

4. The accepted values for the factor of safety of the design were 7.0, 2.1 and 2.5 to 1.0, respectively. Dr. K. Terzaghi established an overall safety factor of 2.0 to 1.0 (Appendix B, Page B-1, Reference 4). These values of safety factors are higher than minimums suggested by the Corps of Engineers (Appendix B, Page B-1, Reference 8).

Evaluation of the stability computations for shearing of the embankment shows fairly conservative assumptions were used; for example, the minimum values of the mechanical properties of rock and earth were used, 100 percent drawdown was assumed and a considerable part of the downstream portion of the dam was assumed to be submerged.

An approximate calculation of the seepage stability of the dam core material was made by the study team using existing design data. A maximum hydraulic head of 94 feet (the difference between the upstream and downstream water

levels) and a thickness of the earth core at base of the dam of 107 feet, provides an hydraulic gradient of (i) = 0.86. This value is less than the value of the critical hydraulic gradient (i_c) for the impervious core, hence the relationship i/i_c is larger than the 1.5 minimum recommended in Appendix B, Page B-1, Reference 8.

A stability analysis of the concrete spillway weir against overturning and sliding was completed by the MDC for cases with varying combinations of cutoff, uplift, ice thrust, foundation anchoring systems and upstream and downstream water pressure. The computations show that the critical case is when the spillway weir does not have a cutoff and anchor bolts. In all other cases, the spillway weir has enough stability. The overturning safety factor varies from 1.12 to 1.0 to 29.2 to 1.0, the sliding safety factor varies from 0.14 to 1.0 to 0.87 to 1.0. The design of the spillway weir includes the cut-off and anchoring to the rock foundation.

c. Operating Records - For reasons of water rights, the Metropolitan District uses the following requirements for the discharge over or through this dam:

1. All natural stream flows up to 150 cfs.
2. Minimum 50 cfs at all times.
3. All releases by State from fishery pool. (The fishery pool releases cannot be counted as part of 50 cfs minimum in 2.)

4. Riparian releases as ordered by Riparian Owners. (Not to exceed 400 mg in any one day nor at a rate greater than 800 mgd where 1 mgd = 1.54 cfs/day).

5. All releases from Otis Reservoir Watershed.

Section 5 discusses the adequate capacity of this spillway and establishes that the diversion channel is not necessary for the safety of the facility.

d. Post Construction Changes - Generally, the dam is in satisfactory condition. The following post construction changes have been noted:

1. Movements of the stone parapet walls at the junction of the gate house walls. The lateral movements were four inches (west end) and six inches (east end). The vertical settlements measured five inches and four inches, respectively. According to the inspection of October 10, 1973, the measurements were three inches and one inch, respectively.

2. Wetting, seepage and leaching of concrete along the horizontal construction joints of the interior walls of the gate house.

3. Considerable seepage from contraction joints and the vertical crack of the diversion channel in the zone near the gate house (the crack was formed

during the construction period. The total seepage discharge is approximately 6 to 7 gallons/minute. This seepage has evidence of leaching of lime from the concrete and rusting of reinforcement in concrete.

4. Corrosion of some metal items in the atmosphere exposed to high humidity and seepage; for example, the steel balcony in the diversion channel.

5. Minor spalling at the construction joints in the apron of the diversion channel.

6. Abutment cracks on the western end adjacent to the rollers at the northern and southern faces of the spillway channel bridge.

e. Seismic Stability - The dam is located in seismic zone number 1 and in accordance with Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - The geological, design and construction data, the results of the hydraulic model tests, the visual observations, the operating records, the post construction changes and the results of this inspection permits, the conclusion that the general condition of the dam and its appurtenant structures is good. The stability and reliability of the dam, its slopes and foundation is adequate and insures its operation for the design conditions.

b. Adequacy of Information - The assessment of the condition of the dam can be based on the information available as well as the visual inspection.

c. Urgency - The owner shall implement the recommendations and remedial measures described in the following sections within two to three years after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the following actions be undertaken by the owner:

1. Continue the ordinary inspections of the dam that have been started by the Metropolitan District with special attention to the vulnerable spots of

the dam, such as seepage from joints and cracks in the concrete of the gate house and diversion tunnel and the movements of the parapet walls on top of the dam in the area of the gate house.

2. Establish permanent monitoring of the behavior of the dam for the following observations:

   (a). Movements of the parapet walls relative to the gate house. The frequency of the readings should be yearly.

   (b). Seepage discharges through the dam in the zone of the diversion tunnel. The discharges should be measured in the two horizontal drains located at the outlet of the tunnel. The frequency of these readings is suggested monthly.

   (c). Seepage discharges through the contraction joints and the vertical crack in the diversion tunnel from an area located near the downstream wall of the gate house. The frequency of these readings is suggested monthly.

   (d). Temperature of seepage water so that additional information about the behavior of the structure can be formulated. The frequency of readings should be monthly.

Any of the above recommendations that require additional investigations should be done by a qualified engineering firm.

7.3 Remedial Measures

It is considered important that the following items be attended to as early as practical:

a. Alternatives - Not applicable.

b. O & M Maintenance and Procedures -

1. Movement markers for monitoring of movements of the parapet walls relative to the gate house should be installed.

2. Arrangements for metering of seepage discharges through the cracks, contraction joints and horizontal drains into concrete of the diversion tunnel should be commenced.

3. Seepage cracks and joints into concrete of diversion tunnel should be repaired.

4. Round-the-clock surveillance because of the location of the dam upstream of a populated area should be provided if spillway discharge from Colebrook Dam is anticipated or occurring. In addition, the owner should develop a formal system for warning downstream residents in case of an emergency.

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Goodwin Dam (Hogback) DATE: 6-1-78

TIME

WEATHER Sunny

W.S. ELEV. 641.26 U.S. 534.0 DN.S.

PARTY:

1. Richard Lyon
2. Miron Petrovsky
3. Gary Giroux
4. John Schearer
5. Peter Revill (MDC)
6. John Pozzato
7. Otis Matthews
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Air Temperature	75° F
Upstream Temperature	59° F
Downstream Temperature	40° F

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME R. Lyon

DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	Excellent condition
Current Pool Elevation	Excellent condition
Maximum Impoundment to Date	Excellent condition
Surface Cracks	None observed
Pavement Condition	Good
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	None observed
Horizontal Alignment	Good alignment
Condition at Abutment and at Concrete Structures	Good condition at abutment
Indications of Movement of Structural Items on Slopes	Five inches of settlement at gate house
Trespassing on Slopes	None permitted
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	No failures
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	None
Piping or Boils	None
Foundation Drainage Features	None (Rounded on Rock)
Toe Drains	Foundation drains not found - underdrain
Instrumentation System	None used

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME M. Petrovsky

DISCIPLINE _____ NAME J. Schearer

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Underwater
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Excellent shape (steel slide gates)
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME J. Pozzato

DISCIPLINE _____ NAME O. Matthews

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	
General Condition	Good
Condition of Joints	Good
Spalling	None
Visible Reinforcing	None
Rusting or Staining of Concrete	Some leaching spots in tower
Any Seepage or Efflorescence	Some at lower level
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	Underwater
Cracks	Small hairline cracks in roof beams- studied by MDC
Rusting or Corrosion of Steel	Railing in stairwell corroded due to dampness
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	Electric bridge crane (under repair
Elevator	None
Hydraulic System	None
Service Gates	Sluice gates
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	Diesel- Good
Wiring and Lighting System in Gate Chamber	Good

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME M. Petrovsky

DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Good
Rust or Staining on Concrete	Some observed at joints and hairline cracks .
Spalling	None
Erosion or Cavitation	Slight amount of flow
Cracking	Some at gate house and between 1st and 2nd construction joints
Alignment of Monoliths	very good
Alignment of Joints	very good
Numbering of Monoliths	13

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME M Petrovsky

DISCIPLINE _____ NAME R. Lyon

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Granite Block - good condition
Rust or Staining	None
Spalling	None
Erosion or Cavitation	None
Visible Reinforcing	N/A
Any Seepage or Efflorescence	None
Condition at Joints	Good
Drain holes	None
Channel	Cut in rock (firm condition)
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Good - scour at gate

Note: Riprap next to wingwall is washing out or slightly scoured.

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME M. Petrovsky

DISCIPLINE _____ NAME R. Lyon

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach ~~Channel~~ Ramp	
General Condition	Underwater
Loose Rock Overhanging Channel	N/A
Trees Overhanging Channel	N/A
Floor of Approach Channel	Underwater
b. Weir and Training Walls	
General Condition of Concrete	Good
Rust or Staining	None
Spalling	None
Any Visible Reinforcing	No
Any Seepage or Efflorescence	None observed (1" water flowing)
Drain Holes	None
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	Some observed in bottom of channe
Trees Overhanging Channel	None
Floor of Channel	Good (except loose rock)
Other Obstructions	None

PERIODIC INSPECTION CHECK LIST

PROJECT Goodwin Dam DATE 6-1-78

PROJECT FEATURE _____ NAME R. Lyon

DISCIPLINE _____ NAME G. Giroux

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	
Bearings	Good
Anchor Bolts	N/A
Bridge Seat	Good
Longitudinal Members	Good
Under Side of Deck	Good
Secondary Bracing	N/A
Deck	Good
Drainage System	Good
Railings	Good
Expansion Joints	Sliding plates (good)
Paint	Concrete
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat & Backwall	Good

APPENDIX B

LIST OF REFERENCES

Reference numbers 1 through 7 are located at MDC Headquarters, 555 Main Street, Hartford, Connecticut.

1. "Construction of Hogback Dam". Contract 288. The Metropolitan District in Hartford, County, Connecticut; Water Bureau; 1955.

2. "Hogback Dam Model for Water Bureau". The Metropolitan District; Hartford 5, Connecticut; Alden Hydraulic Laboratory; Worcester Polytechnic Institute; January, 1954.

3. "Stability Analyses of Proposed Section and Spillway Weir of Hogback Dam". Contract 288. The Water Bureau of the Metropolitan District; Hartford County, Connecticut; 1952 to 1957.

4. Hogback Dam. Reports by Dr. K. Terzaghi, Professor F. E. Richart, Jr.; Professor S. D. Wilson and Dr. L. Casagrande. (Volume 1). Contract 288. The Metropolitan District; Hartford County, Connecticut; 1952 to 1954.

5. "Goodwin Dam Questionnaire for dams, outlets, high head gates and valves". Water Bureau; Metropolitan District; Hartford County, Connecticut.

6. Goodwin Dam - "Inspection of Dams and Spillways". Water Bureau. The Metropolitan District. Hartford County, Connecticut; Reference No. 2-1405; October 10, 1973; April 27, 1976; and May 4, 1976.

7. "Data on Safety of Metropolitan District Dams". Water Bureau. The Metropolitan District; Hartford County, Connecticut.

8. Recommended Guidelines for Safety Inspection of Dams. Department of the Army. Office of the Chief of Engineers; Washington, D.C.; November, 1976.

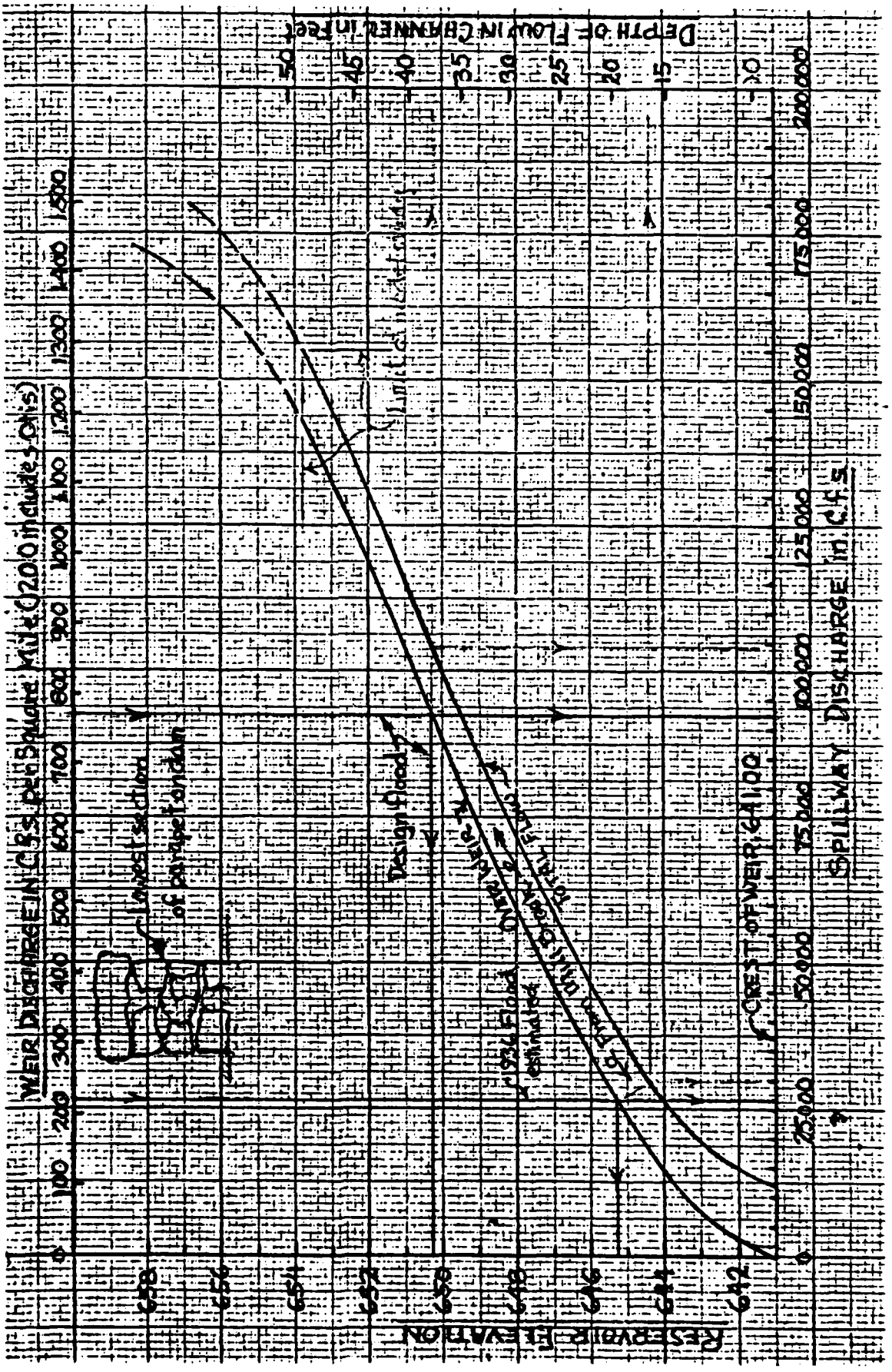
9. Guide Curves for the Probable Maximum Flood (PMF) for Regions of New England based on past Corps Studies, March, 1978.

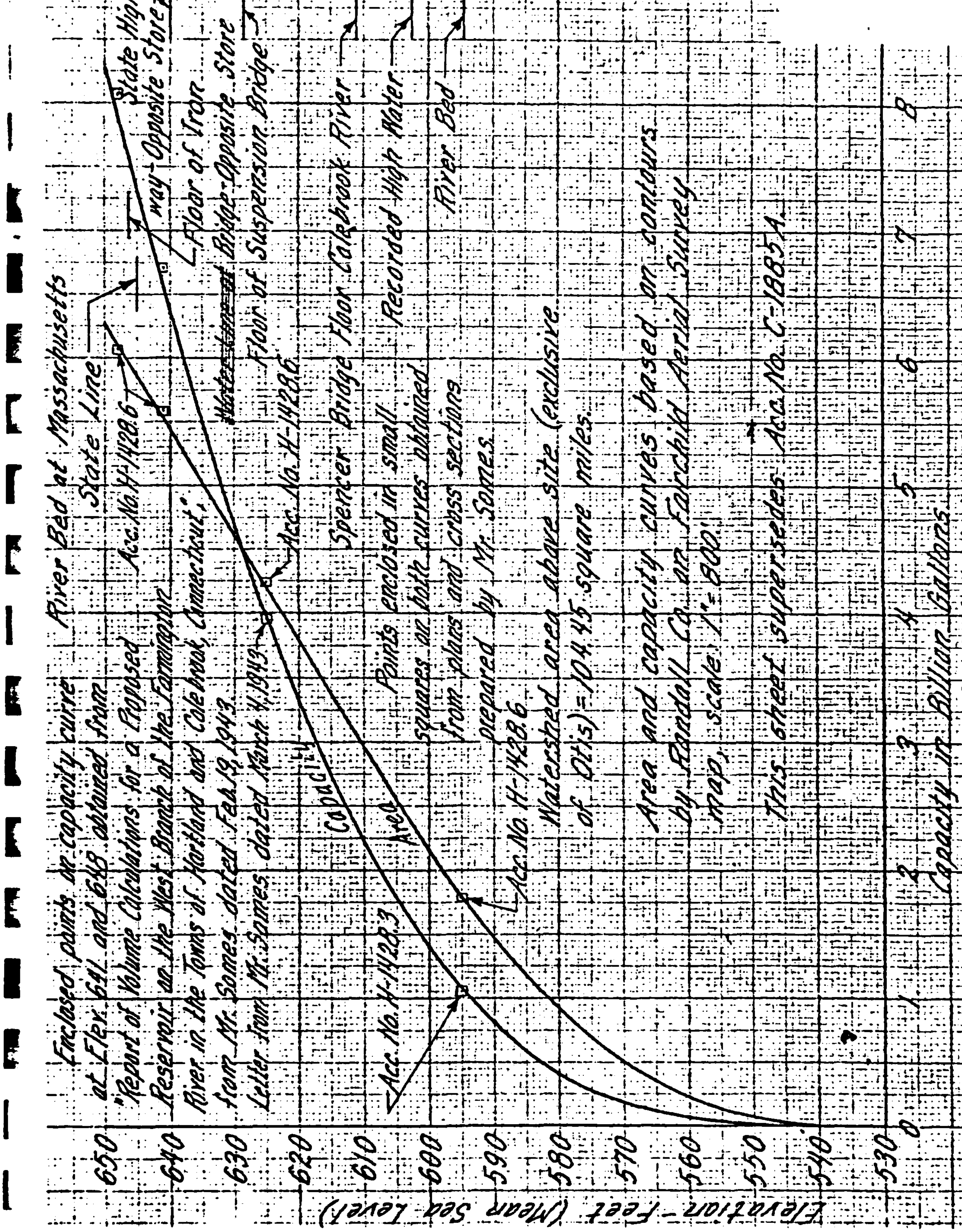
10. Preliminary Guidance for Estimating Maximum Probable Dicharges in Phase I Dam Safety Investigations; New England Division, Corps of Engineers; March, 1978.

11. Rule of Thumb. Guidance for estimating downstream dam failure hydrographs. Corps of Engineers; April, 1978.

12. "Instrumentation of Earth and Rockfill Dams". EM 110-2-1908, 31 August 1971; Department of the Army, Corps of Engineers.

COMPUTATIONS SUPPLIED BY THE METROPOLITAN DISTRICT COMMISSION




Enclosed points on capacity curve at Elev. 641 and 648 obtained from "Report of Volume Calculations for a Proposed Reservoir on the West Branch of the Farmington River in the Towns of Hartland and Colebrook, Connecticut," from Mr. Somes dated Feb. 19, 1943.
Letter from Mr. Somes dated March 4, 1943
Acc. No. H-1428.3
Capacity
Area
Points enclosed in small squares on both curves obtained from plans and cross sections prepared by Mr. Somes.
Acc. No. H-1428.6
Watershed area above site (exclusive of Otis) = 104.45 square miles.
Area and capacity curves based on contours by Randall Co. on Fairchild Aerial Survey map, scale 1" = 800'.
This sheet supersedes Acc. No. C-1885A.
River Bed at Massachusetts State Line
Acc. No. H-1428.6
Acc. No. H-1428.6
State Highway - Opposite Store
Floor of Iron Bridge - Opposite Store
Floor of Suspension Bridge
Spencer Bridge Floor Colebrook River
Recorded High Water
River Bed
650
640
630
620
610
600
590
580
570
560
550
540
530
0
1
2
3
4
5
6
7
8
Capacity in Billion Gallons
Area in Hundred Acres
Elevation - Feet (Mean Sea Level)

The Metropolitan District
artford County, Connecticut
Water Bureau
Designing Division

Des. Div. Ref. No. S- 1405
Date 10-10-73

INSPECTION OF DAMS AND SPILLWAYS

NAME OF DAM Goodwin Dam

LOCATION (Town, River, Reservoir) Hartland

INSPECTORS	Name	Title	Div./Dept.
	Dick Allen	Asst. Engineer	S & P
	Dick Conopask	Sr. Engineer	Design

In filling out this form, please enter full information on conditions, and on location of any defects.

A. GENERAL

1) Were any photographs taken of the dam during this inspection Yes

2) Reservoir level, Elev. 619.60

3) Weather (including comment on humidity) Cool, clear, sunny, dry (beautiful fall day - excellent foliage).

B. EARTH DAMS

1) Note any depressions in crest None

2) Slides and/or erosion, upstream face None

3) Slides and/or erosion, downsteam face None

4) Cracks in embankment None

5) Surfacing on crest and condition Penetration macadam - excellent.

6) Condition of parapet walls, if any Excellent

7) Seepage on downstream face, especially at toe, (location and quantity) None

8) Soft ground at toe (locate) None

9) Signs of settlement at gate house and/or gate house bridge Parapet settled W/S - 3" @ G.H.; Parapet E/S-1" @ G.H. See Pictures #2 and #3.

10) * Downstream drainage system (clear or blocked, etc.) Clear - stone paved ditches on berms should be de-grassed.

11) Type and condition of downstream face planting grass-good.

12) Is planting and/or debris etc. a fire hazard? No

13) Do plantings obscure toe of dam and other points where monitoring inspection is necessary? No, exceptionally clear - See Picture #1

14) Damage or vandalism (to lights, plaques, etc.) door knobs damaged; dents from thrown rocks in G.H. door; U.S. flag stolen periodically.

15) Other Intrusion alarm in G.H. intentionally activated frequently by vandals.

C. CONCRETE DAMS

1) Any signs of motion

* Drain pipe outfalls @ toe of dam should continue to be de-brushed.
Small culvert on access road on west downstream side of dam needs cleaning.

2) Deterioration noted:

Upstream face _____

Downstream face _____

Road/walk on crest _____

Parapets _____

Spillway _____

Other (excluding gate houses) _____

_____

3) Inspection Gallery:

General condition _____

Leakage _____

Lime accumulation _____

Flooding & drainage _____

Other _____

_____

4) Damage or vandalism (to lights, plaques, etc.) _____

_____

5) Other comments _____

_____

_____

D. GATE HOUSES

1) Upper House

1) Exterior: walls Excellent - See Pictures #4 and #5.

windows Good - 2 lights middle window west side broken.

doors Gen. Good - slight weathering problem.

roof Excellent - new roof in 1972.

2) Superstructure Interior:

walls Excellent - See Picture #6.

floor Excellent

ceiling Good - Cracks in ceiling beams - See Picture #7

3) Leakage into superstructure None

4) Substructure, interior:

Leakage and condensation both moderate

Condition of metal work (stairs, etc.) Good in upper chamber - lower metal work is rusty - See Pictures #8, 9 and 10.

5) Equipment condition:

Sluice gates OK

Gate valves OK

Piping -

Electrical gear OK

Other Diesel OK

6) Do all electric lights work Yes

7) Condition of stop logs in storage well Good - those stored at lower elev. are getting rusty.

8) Operating personnel comments on functional condition of all equipment (valves, hoists, selector gates, trash racks, screens, etc.) Generally excellent - west rail on trolly, section of rail is warped causi wire pull out (motor feed) when operated - should be replaced.

9) Last time various wells and other underwater portions were unwatered and examined (Give name of well and date in case of multiple wells).

_____

_____

_____

10) Other comments Dehumidification and/or heating recommended in stairwell. See Pictures #8 and #9.

_____

_____

ii) Lower House

1) Exterior: walls _____

windows _____

doors _____

roof _____

2) Superstructure Interior:

walls _____

floor _____

ceiling _____

3) Leakage into superstructure _____

_____

4) Substructure, interior:

Leakage and condensation _____

_____

Condition of metal work (stairs, etc.) _____

_____

5) Equipment condition:

Sluice gates _____

Gate valves _____

Piping _____

Electrical gear _____

Other _____

6) Do all electric lights work _____

7) Condition of stop logs in storage well _____

8) Operating personnel comments on functional condition of all equipment (valves, hoists, selector gates, trash racks, screens, etc.) _____

9) Other comments _____

iii) Conduit between gate houses Stream flow tunnel - See Picture #16.

1) Concrete condition Good

2) Leakage Moderate - @ 1st & 2nd constr. joints in roof.

3) Condition of metal work and piping Piping not inspectable w/flow Balcony - Poor, very rusty.

4) Other comments Balcony supports should be inspected in detail w/no flow - Recommend repalcing steel balcony w/aluminum or stainless steel balcony- See Picture #10.

E. PRINCIPLE SPILLWAY

(If spillway is part of dam, enter information in C only).

1) Weir Excellent, minor spalling at constr. joints in apron.

2) Channel Excellent - side slopes stable.

3) Outlet of channel

4) Note any obstructions to flow Minor rock falls immediately no. & so. of brid

5) Bridge Excellent - abutment cracks on west end adjacent to rollers (both north and south faces) see pictures #11 and #12.

6) Is water spilling No

7) Other comments Recommend installation of 6' fence along east side of spillway channel from bridge to natural steam bed of Mills Brook; also from bridge downstream to end of channel on east side. See Picture #13. Also recommend some type of barrier to prevent easy access to spillway weir from parapet wall, See Picture #14.

F. EMERGENCY SPILLWAY

1) Channel

2) Obstructions

3) Other comments

G. APPURTENANT STRUCTURES

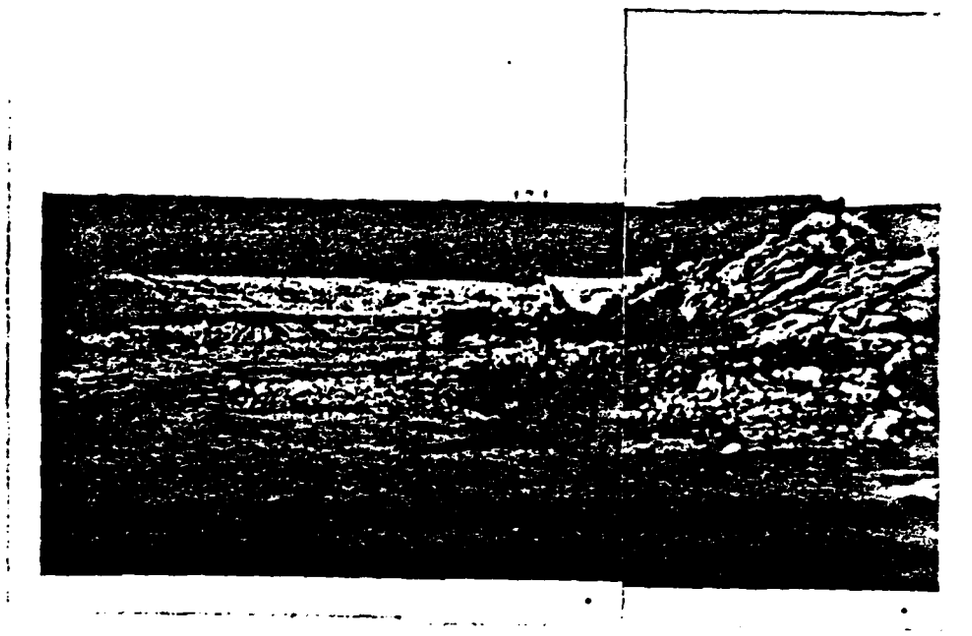
List structure (such as stilling pools, discharge weir structures, stream diversion works, etc. and give conditions.

Mills (Thorn) brook channel - excellent, side slopes stable.

H. OVERALL ASSESSMENTS

Is this dam with its appurtenances maintained in a condition satisfactorily to the Inspectors? Excellent, lack of recreation population loading eases exterior maintenance requirements.

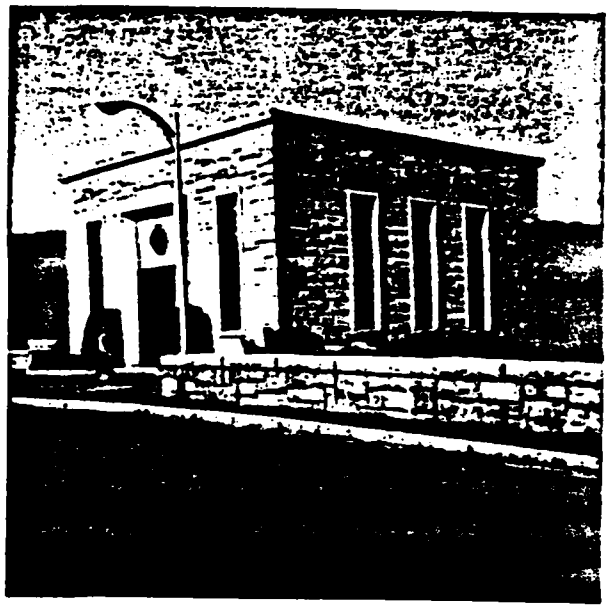
GOODWIN DAM



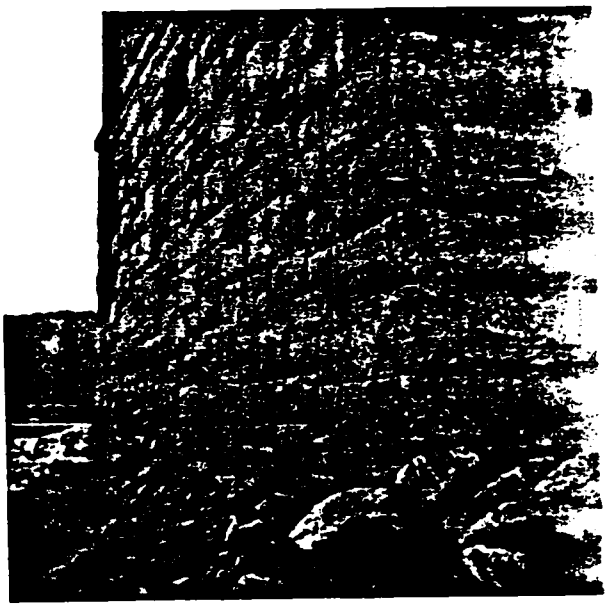
#1. Showing good conditions on downstream face and toe of slope.

#2. Parapet wall settlement at west side of upper Gate House.

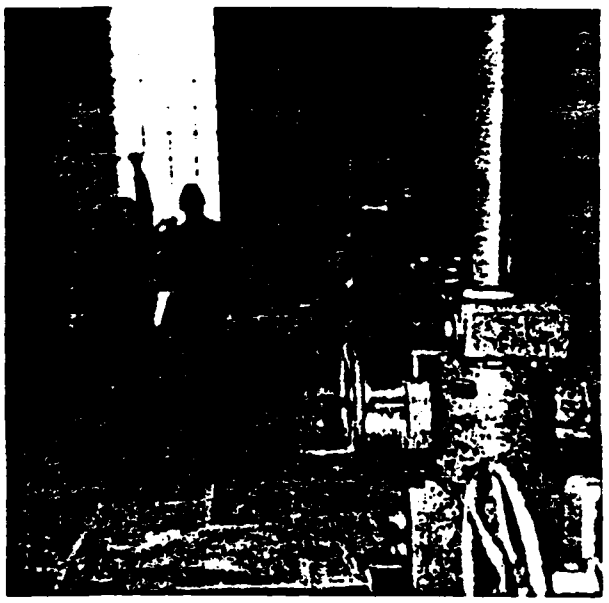
#3. Parapet wall settling has caused some minor joint separation on upstream si adjacent to Upper Gate Ho



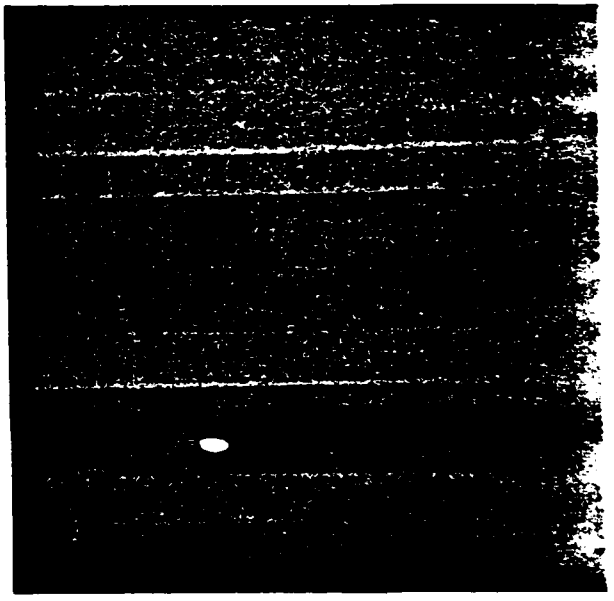
#4. Upper Gate House is in excellent condition.



#5. Upstream face of Upper G--- House shows no ice damag

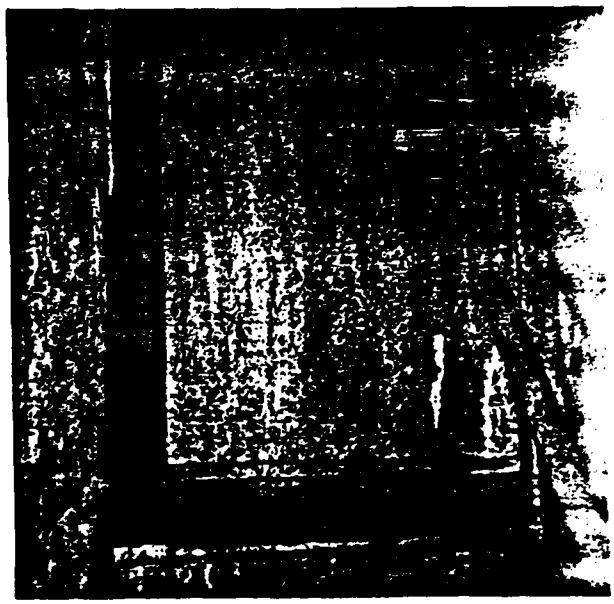


#6. Excellent conditions on Upper Gate House interior.



#7. Ceiling beams in Upper Gat House are cracked near cent Should continue to be mon- tored.

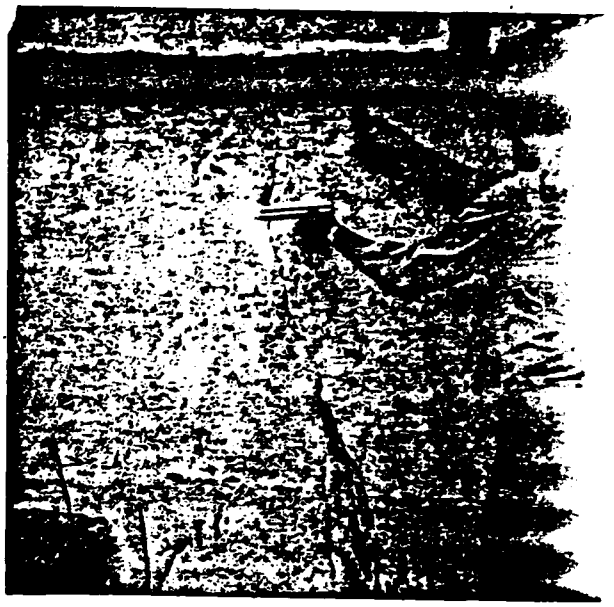
#8. Lime leaching at first joint below water line.



#9. Generally wet below water line.

#10. Poor conditions in stream flow tunnel.

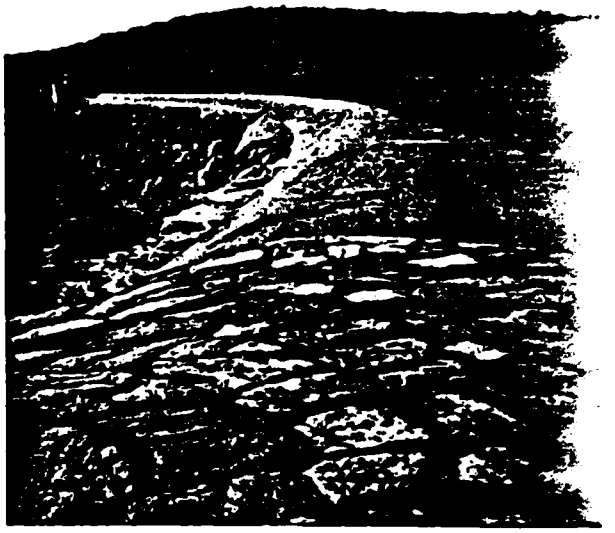
#11. South face at West end. Finger points to location of rollers.



#12. North face at West end. Finger points to location rollers.

#13. Rock cut on east side of spillway channel is presently accessable from woods and is a potential hazard to casual wanderers.

#14. There is presently no effective barrier to upstream west side of spillway channel.



#15. This area is directly accessable from point indicated in picture #14

#16. Outlet of stream flow tunnel passing 230 cfs.

THE METROPOLITAN DISTRICT
HARTFORD COUNTY, CONNECTICUT
WATER BUREAU
DESIGNING DIVISION

REF. NO. S- 1405
DATE 27 April 19

INSPECTION OF WATER BUREAU FACILITIES

SYSTEM Supply FACILITY Dam

NAME OF FACILITY Goodwin Dam

LOCATION W. Br. Farmington R.
Tunnel well & Lower inlet well

INSPECTORS:	NAME	TITLE	DIVISION/DEPT.
	P.J. Revill	Ch. Des. Engr.	Designing

CONDITION OF FACILITY:

Tunnel well & tunnel heading entered, lower inlet well only seen from floor & 6'x6' sl. gate.
Concrete Note a lot of lime deposits on walls of tun. well below lower constr. joints. Also lime on roof of part of tunnel transition. Tunnel entered 150'± only. Usual transverse cracks & lime "drippings". Much debris on floor - gravels, misc. materials. Floor probably sound, but water t. deep to determine. Very little seepage.
Metalwork. In tunnel well - excellent. In lower inlet well what could be seen - good/excellent.

WORK SUGGESTED BY OPERATING AUTHORITY:

None

RECOMMENDATIONS:

No work necessary.
Inspect in 1981.

Attachment ✓ (None), B-18 (Number)

HE METROPOLITAN DISTRICT
T ORD COUNTY, CONNECTICUT
WATER BUREAU
DESIGNING DIVISION

REF. NO. S- 1405
DATE 4 May 1976

INSPECTION OF WATER BUREAU FACILITIES

SYSTEM Supply FACILITY Dam

NAME OF FACILITY Goodwin Dam

~~LOCATION~~ River flow wells & outlet conduit

INSPECTORS:	NAME	TITLE	DIVISION/DEPT.
	L.E. Kirk	Sr Eng.	Construction
	P.J. Revill	Ch. Des. Eng.	Designing

CONDITION OF FACILITY:

Intake & E+W river flow wells & connecting waterway inspected only from invert. Wells viewed by floodlight but not climbed or travelled. General condition: excellent. A little concrete erosion at invert of inlet well, 3"± deep - not serious. Metal work all seen sound & reasonably free of rust or tuberculations. Inlet well ladder has lost bolts at 2 lower wall brackets, has no floor bolts. Screen cage over 6" sl.gt. in West well missing. Stainless steel bolts in outlet increasers in conduit intact.
Outlet conduit - fair, has some leaks, floor erosion not more than seen years before. West drain over block next to endwall gate has heavily rust colored water.

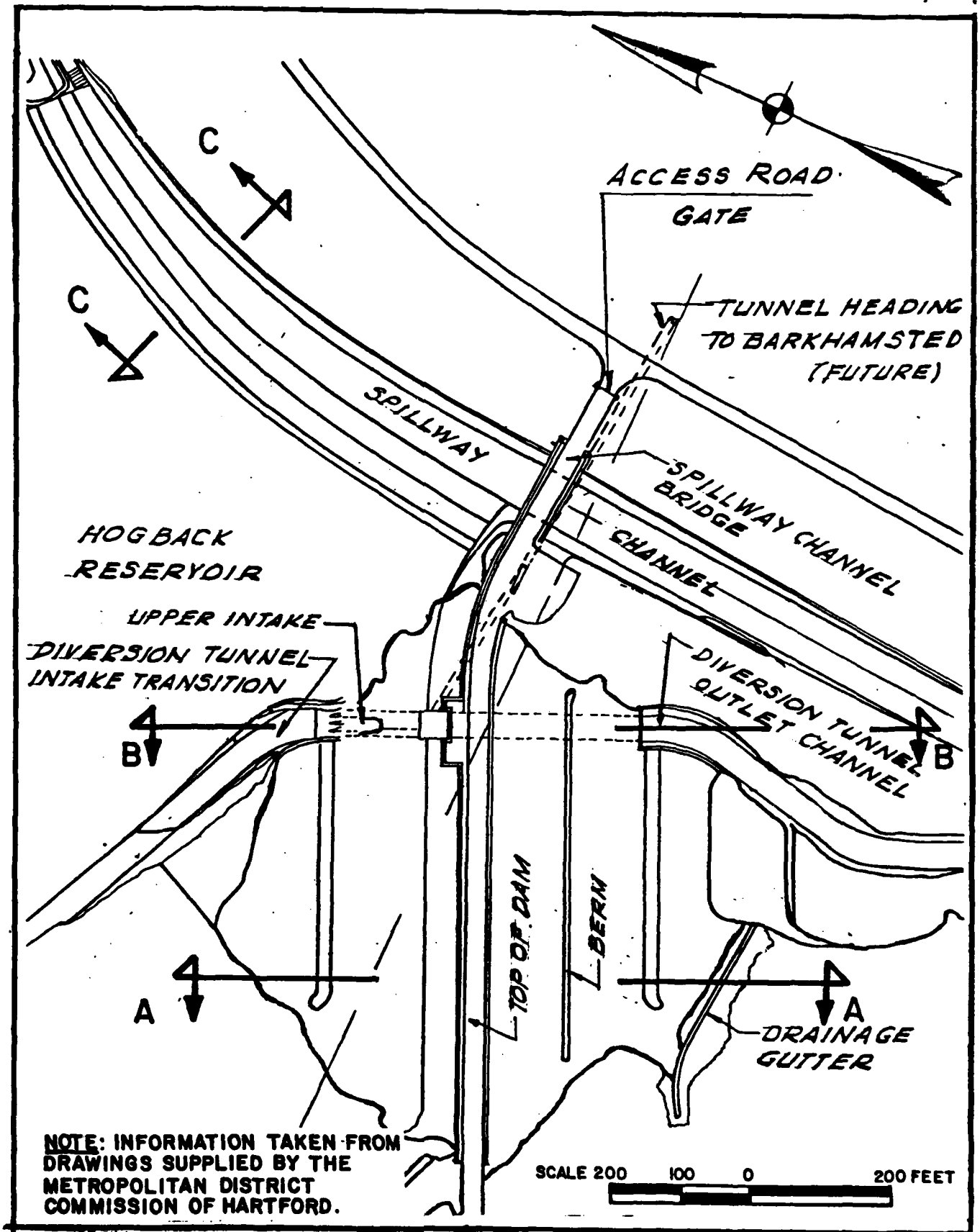
WORK SUGGESTED BY OPERATING AUTHORITY:

RECOMMENDATIONS:

Repair ladder in inlet well with stainless steel nuts, bolts washers. Reinspect in 1981.

Photos taken. See over.

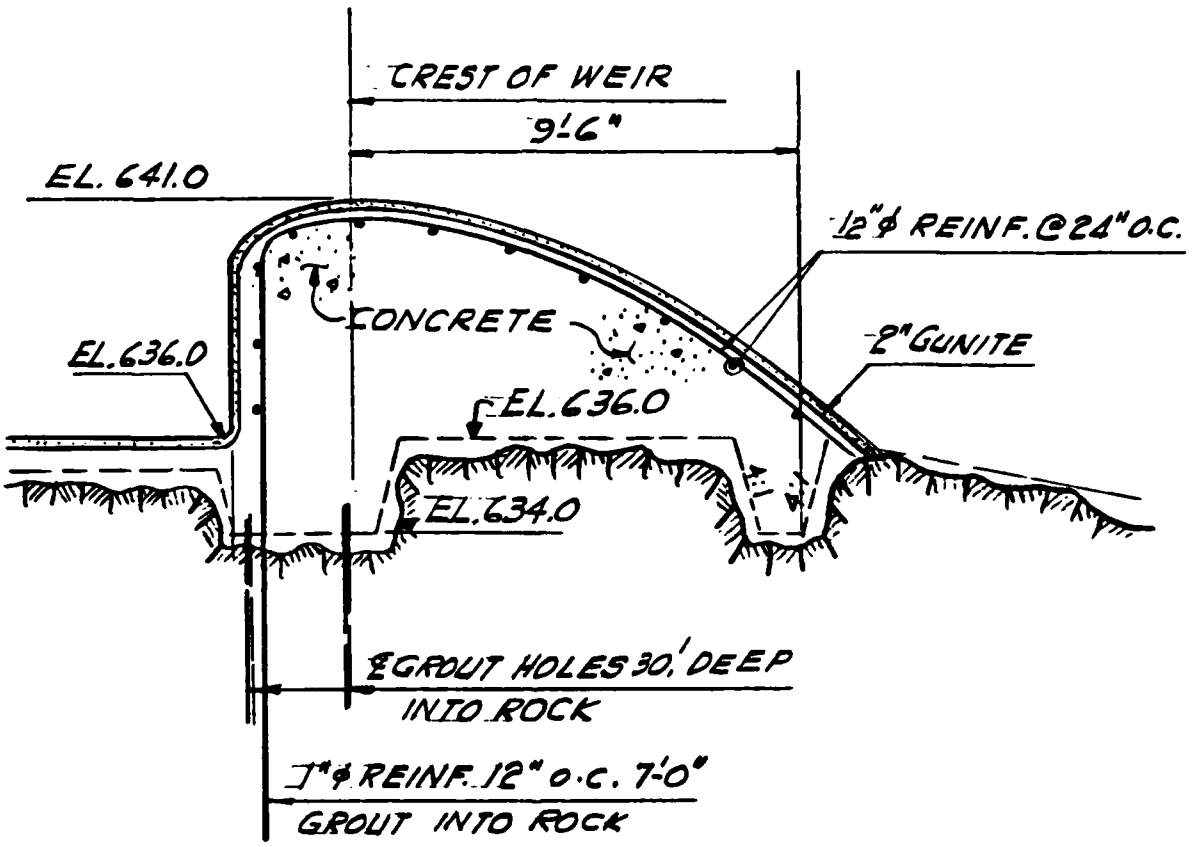
Attachment (None), B-19 (Number)



U.S. ARMY, CORPS OF ENGINEERS
NEW ENGLAND DIVISION
WALTHAM, MASS.

GOODWIN DAM
GENERAL PLAN

PLATE-1



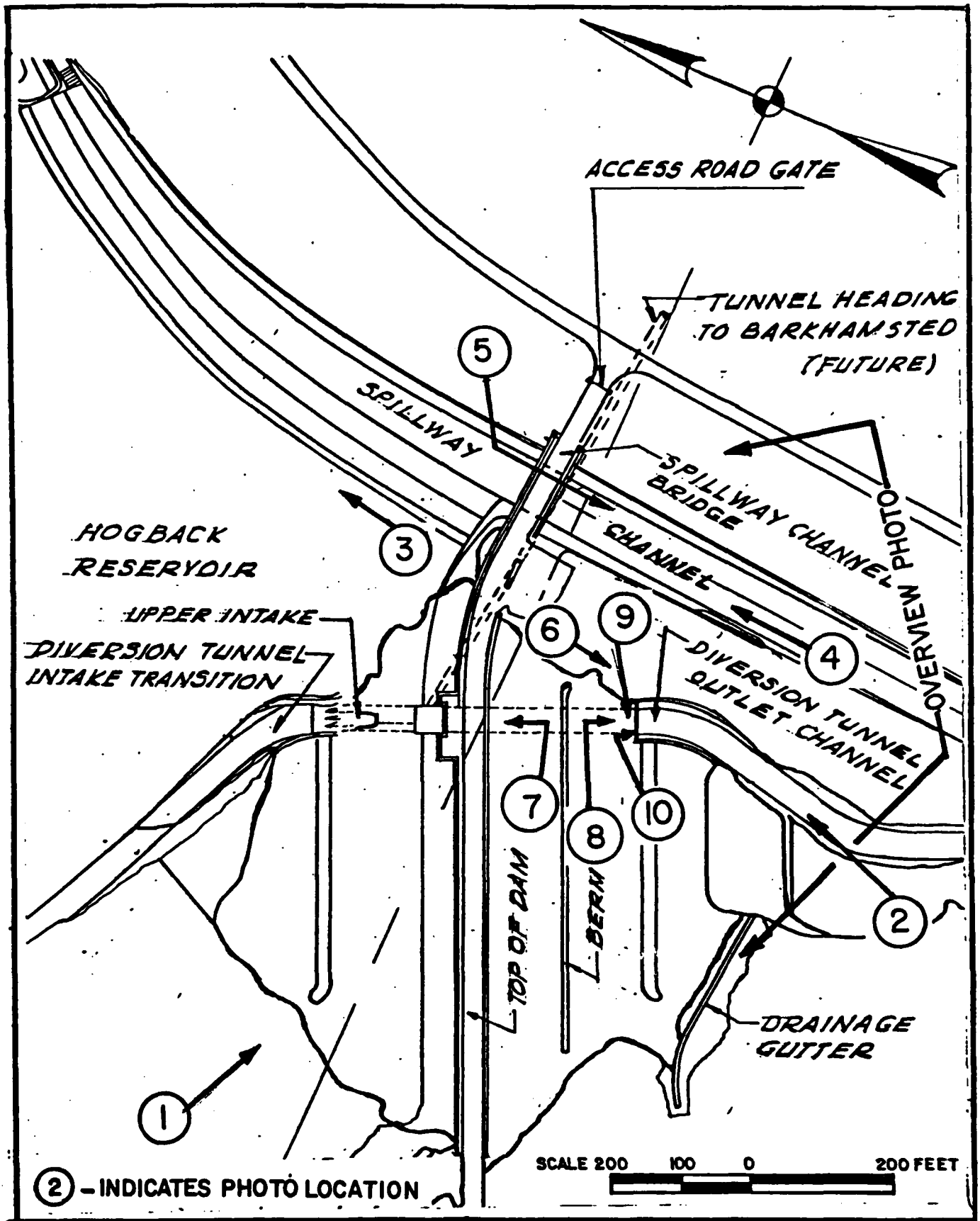
SECTION C-C

Not to Scale

NOTE: INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY THE METROPOLITAN DISTRICT COMMISSION OF HARTFORD.

U.S. ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION WALTHAM, MASS.	GOODWIN DAM SECTION AND DETAILS	PLATE-4

APPENDIX C



U.S. ARMY, CORPS OF ENGINEERS
NEW ENGLAND DIVISION
WALTHAM, MASS.

GOODWIN DAM

PHOTO LOCATION PLAN

PLATE-5

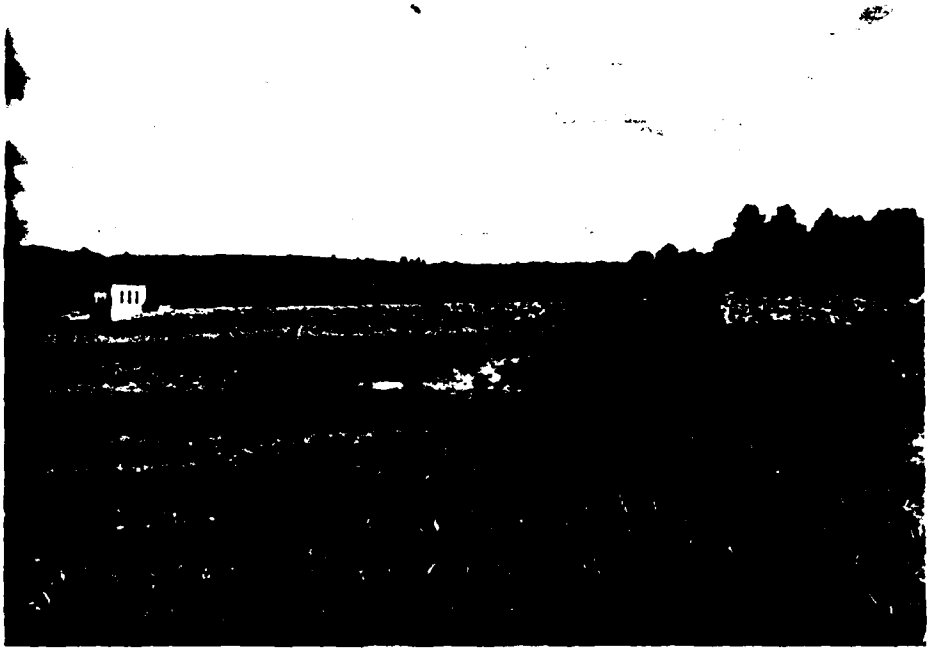


PHOTO 1
UPSTREAM FACE OF DAM AND GATE HOUSE

PHOTO 2
DIVERSION TUNNEL - OUTLET

PHOTO 3
SPILLWAY WEIR

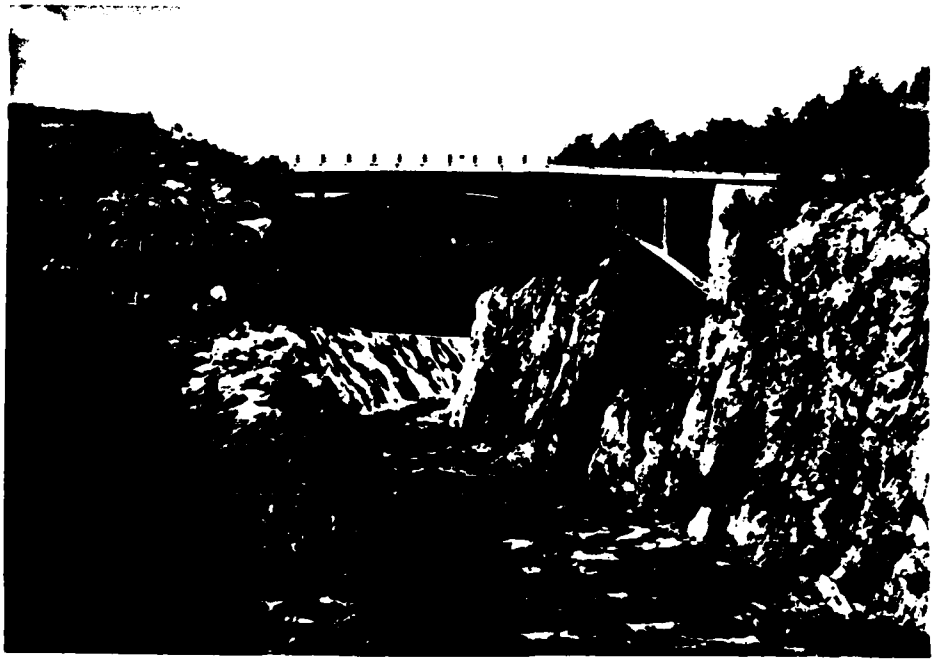


PHOTO 4
SPILLWAY CHANNEL AND SERVICE BRIDGE

PHOTO 5
SPILLWAY CHANNEL

PHOTO 6
DOWNSTREAM CHANNEL

PHOTO 7

DIVERSION TUNNEL - LOOKING UPSTREAM TOWARD GATES

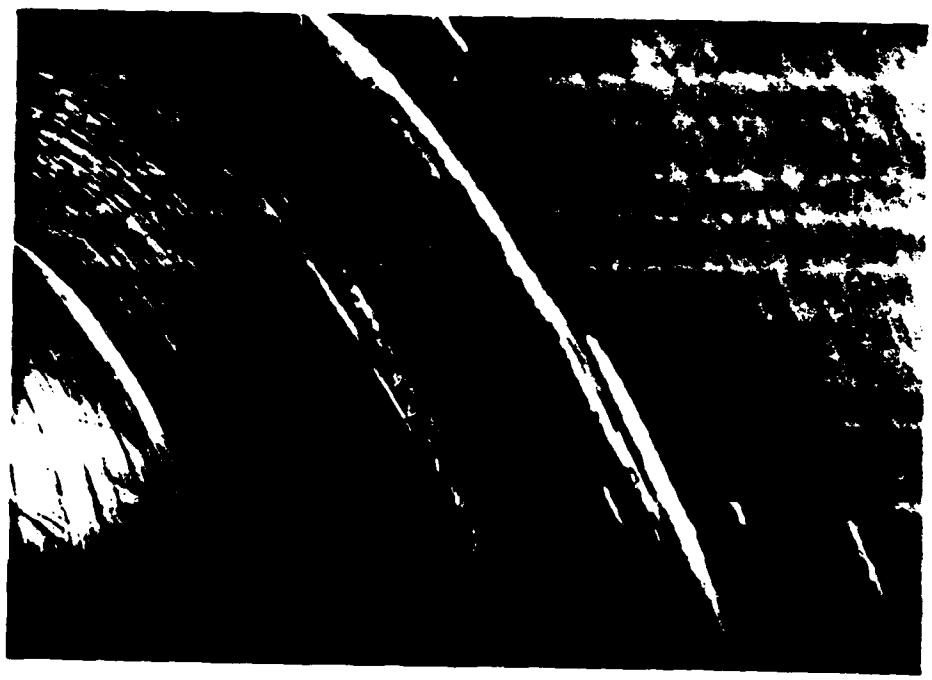


PHOTO 8

DIVERSION TUNNEL - CONSTRUCTION JOINTS

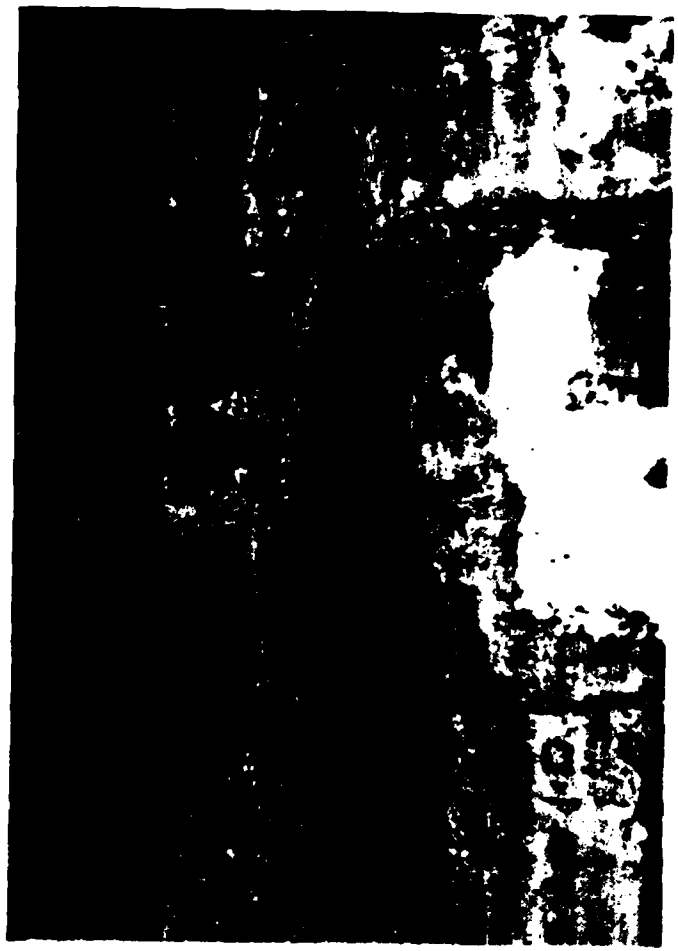


PHOTO 9
SEEPAGE OUTLET - END OF DIVERSION TUNNEL

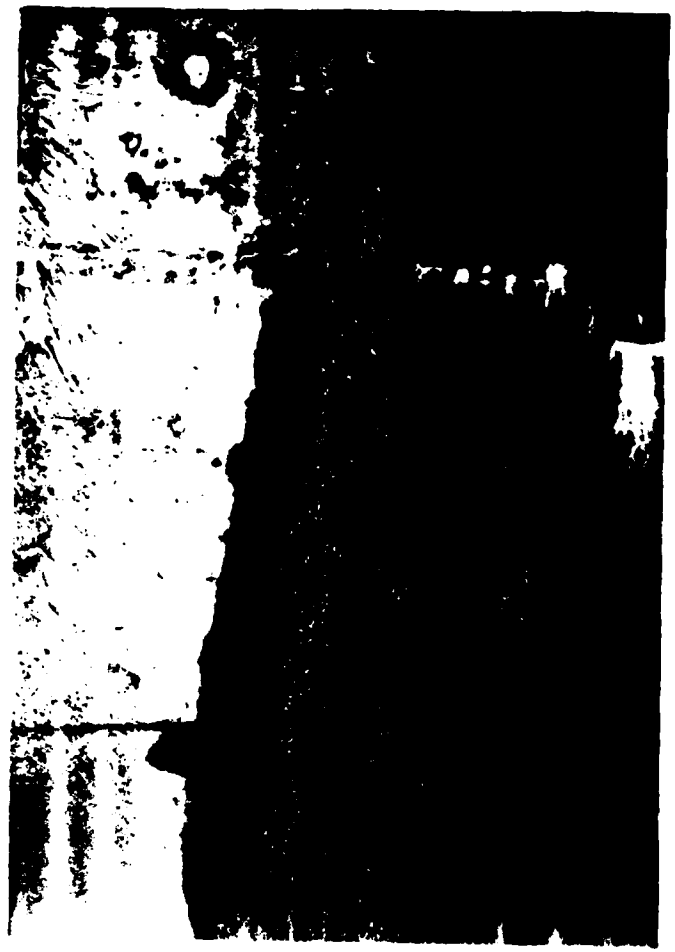


PHOTO 10
SEEPAGE OUTLET - END OF DIVERSION TUNNEL

APPENDIX D

STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS

I Section @ Dam

① $S = 17,680$ Ac-ft

② $Q_{P_1} = 8/27\, W_b \sqrt{g}\, Y_0^{3/2} = 8/27 (320)\sqrt{32.2}\,(125)^{3/2} = 751,915$ cfs

③ see stage discharge sheet

II Section @ Rte 20 - Riverton (409)

④ A. $D_2 = 41.5'$, $A_2 = 28,000$ ft²

$L_1 = 11,500'$

$V_1 = 7390$ Ac-ft

B. $Q_{P_2} = 751,915 (1 - 7390/17680) = 437,625$ cfs

C. $D_2 = 31.5'$ $A_2 = 17,600$ ft²

D. $A_{avg} = 22,800$ $V_{avg} = 6020$ Ac-ft

$Q_{P_2} = 751915 (1 - 6020/17680) = 495,890$ cfs

$D_2 = 34'$ $A_2 = 19,200$ ft²

III Section @ American Legion State Forest (460)

⑤ A. $D_2 = 34'$

$A_2 = 19200'$

$L_2 = 12,000'$

$V_2 = 5290$ Ac-ft

B. $Q_{P_3} = 495,890 (1 - 5290/17680) = 347,520$ cfs

C. D_3 28.5' $A_3 = 13,920$ ft²

D. $A_{avg} = 16560$ ft² $V_{avg} = 4560$ Ac-ft

$Q_{P_3} = 495890 (1 - 4560/17680) = 367,990.$ cfs

$D_3 = 29.5'$ $A_3 = 14,880$ ft²

IV Section @ Rte 318 crossing, Pleasant Valley (409)

⑥ A. $D_3 = 29.5'$ $A_3 = 14,880$ ft², $L_3 = 10,000'$

$V_3 = 3416$ Ac-ft

B. $Q_{P_4} = 367,990 (1 - 3416/17680) = 296,890$ cfs

C. $D_4 = 27'$ $A_3 = 12,000$ ft²

D. $A_{avg} = 13,440$ ft² $V_{avg} = 3085$ Ac-ft

$Q_{P_4} = 367990 (1 - 3085/17680) = 303,780$ cfs

$D_4 = 27.6$ $A_4 = 13700$ ft²

V Section @ Rte 44 crossing, New Hartford

④ A. $D_4 = 27.6$, $A_4 = 13700\ ft^2$ $L_4 = 22{,}000'$
$V_4 = 6920\ Ac\text{-}ft$

B. $Q_{P5} = 303{,}780\left(1 - \frac{6920}{17680}\right) = 184{,}880\ cfs$

C. $D_5 = 22'$ $A_5 = 7520\ ft^2$

D. $A_{avg} = 10610\ ft^2$ $V_{avg} = 5385\ Ac\text{-}ft$
$Q_{P5} = 303780\left(1 - \frac{5385}{17680}\right) = 211254\ cfs$
$D_5 = 23.5'$ $A_5 = 8640\ ft^2$

VI Section @ Rte 179, Crossing, Collinsville

⑤ A. $D_5 = 23.5$ $A_5 = 8640$ $L_5 = 23{,}000'$
$V_5 = 41561\ Ac\text{-}ft$

B. $Q_{P6} = 211254\left(1 - \frac{41561}{17680}\right) = 156{,}755\ cfs$

C. $D_6 = 20.5'$ $A_6 = 5920\ ft^2$

D. $A_{avg} = 7280\ ft^2$ $V_{avg} = 3844\ Ac\text{-}ft$
$Q_{P6} = 211254\left(1 - \frac{3844}{17680}\right) = 165{,}320\ cfs$
$D_6 = 21.5'$ $A_6 = 6560\ ft^2$

VII Section @ NY, NH & H RR Crossing, River Glen

⑥ A. $D_6 = 21.5'$ $A_6 = 6560\ ft^2$ $L_6 = 37000\ ft$
$V_6 = 5572\ Ac\text{-}ft$

B. $Q_{P7} = 165{,}320\left(1 - \frac{5572}{17680}\right) = 113{,}220\ cfs$

C. $D_7 = 18'$ $A_7 = 4800\ ft^2$

D. $A_{avg} = 5680\ ft^2$ $V_{avg} = 4824\ Ac\text{-}ft$
$Q_{P7} = 165320\left(1 - \frac{4824}{17680}\right) = 120{,}210\ cfs$
$D_7 = 19'$

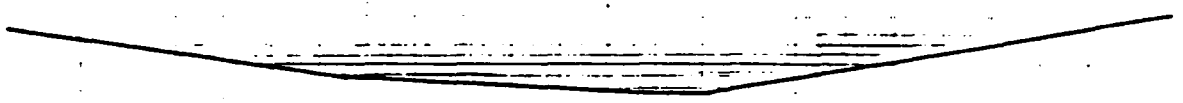
STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

TYPICAL SECTION- FARMINGTON RIVER

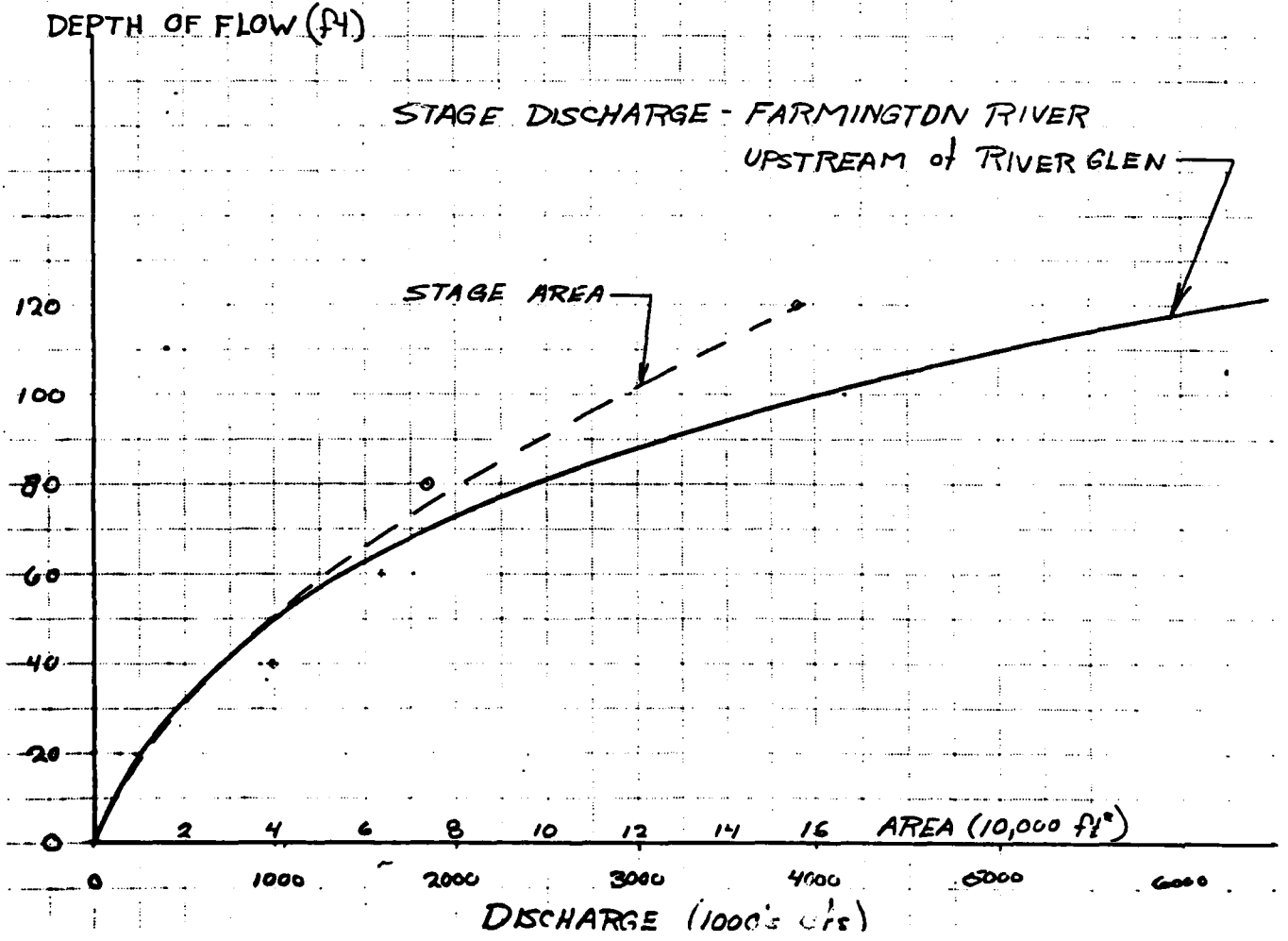
$V = \frac{1.486}{n} R^{2/3} S^{1/2}$

$S = .0028$

$n = .035$ (avg.)



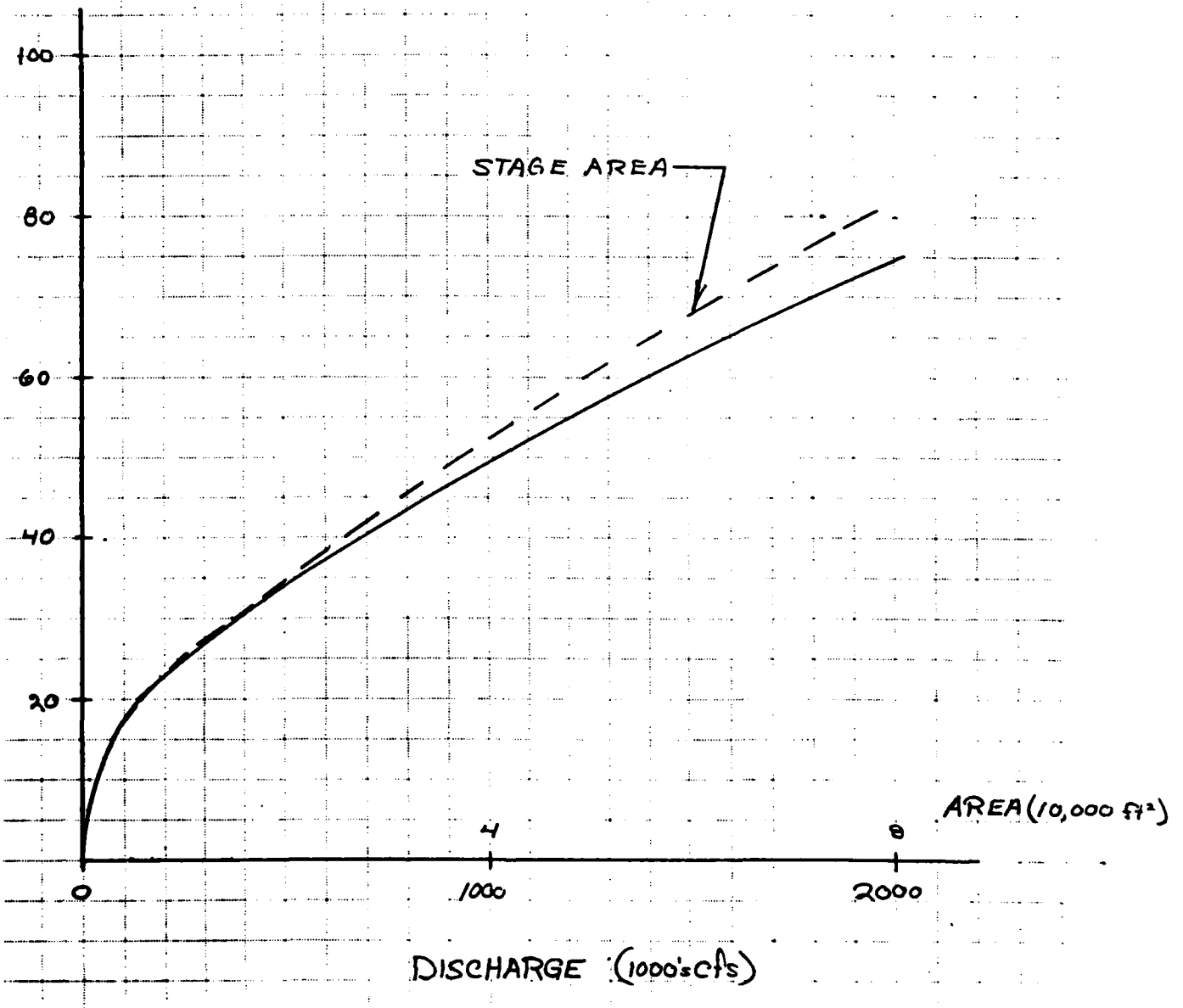
D_{ft}	WP_{ft}	A_{ft^2}	R	$R^{2/3}$	$S^{1/2}$	V_{fps}	Q_{cfs}
10	300	2000	6.67	3.54	.0527	7.92	15,840
20	590	9600	16.27	6.43	.0527	14.4	138,240
40	1230	40,000	32.52	10.2	0527	22.8	912,000
60	1480	64000	43.24	12.33	.0527	27.62	1,767,680
80	1670	73600	44.08	12.49	.0527	27.98	2,059,151
100	1890	118,400	62.65	15.79	.0527	35.37	4,187,760
120	2100	156,800	74.67	17.75	.0527	39.76	6,234,368



STORCH ENGINEERS
Engineers - Landscape Architects
Planners - Environmental Consultants

TYPICAL SECTION - FARMINGTON RIVER

STAGE DISCHARGE (LOW FLOW)
UPSTREAM of RIVER GLEN -



APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY	MO	YR
CT	541	NED	CT	003	06				GOODWIN DAM	4159.3	7301.2	18	AUG	78

POPULAR NAME	NAME OF IMPOUNDMENT
HUGSBACK DAM	WEST BRANCH RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	WEST BRANCH FARMINGTON RIVER	RIVERTON	1	300

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
RBERMPG	1960	S	125	117	17640	13900	NED	N	N	N	N	18AUG78

REMARKS

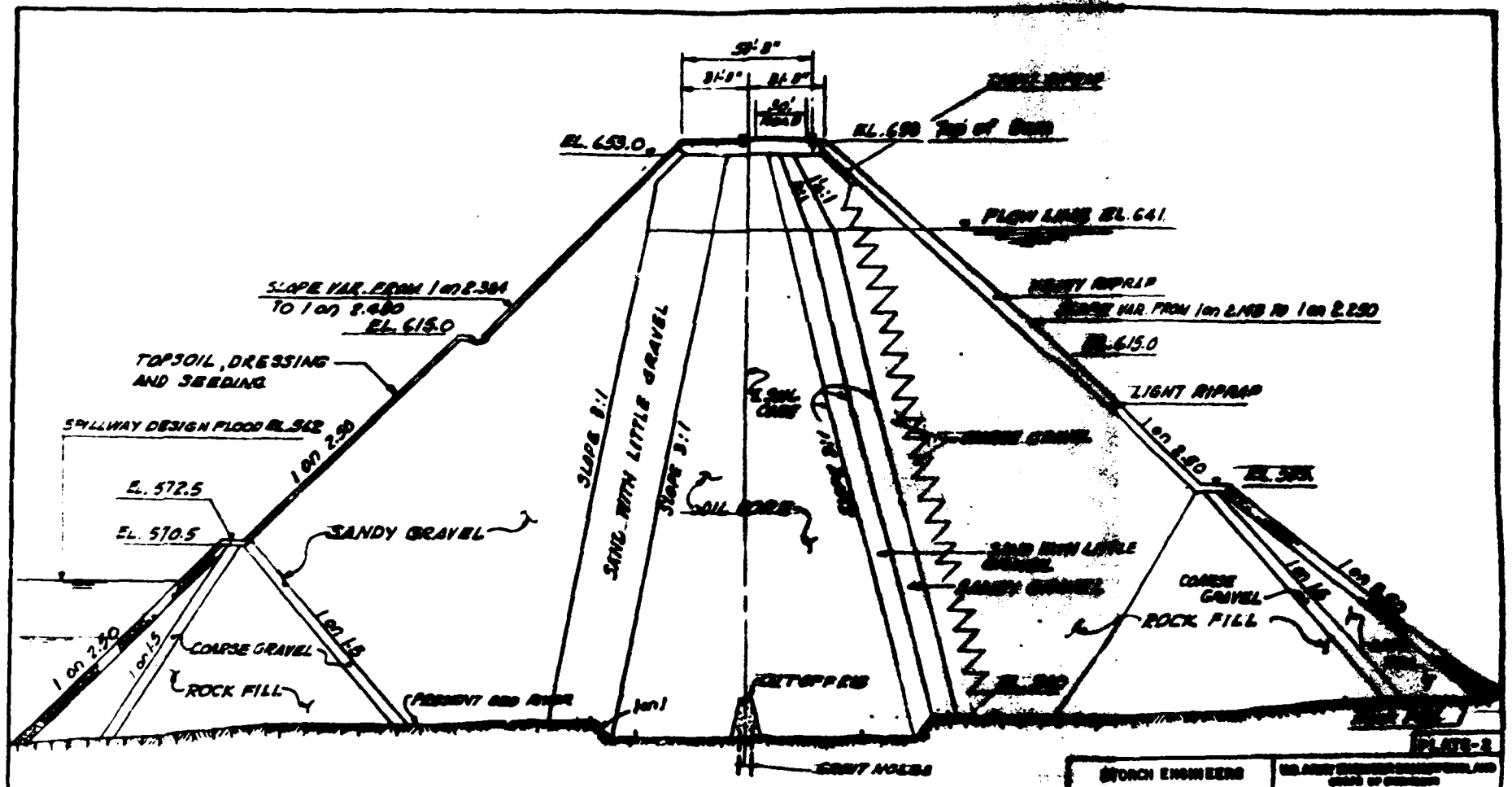
D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	800	U	900	92000	650000											

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOL DISTRC HARTFORD	METROPOL DISTRC HARTFORD	WHITE OAK EXCAVATORS PLA

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY	MO	YR	AUTHORITY FOR INSPECTION
STORCH ENGINEERS	01	JUN	78	PL92-367

REMARKS



SECTION A-A

Not to Scale

NOTE: INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY THE METROPOLITAN DISTRICT COMMISSION OF HARTFORD.

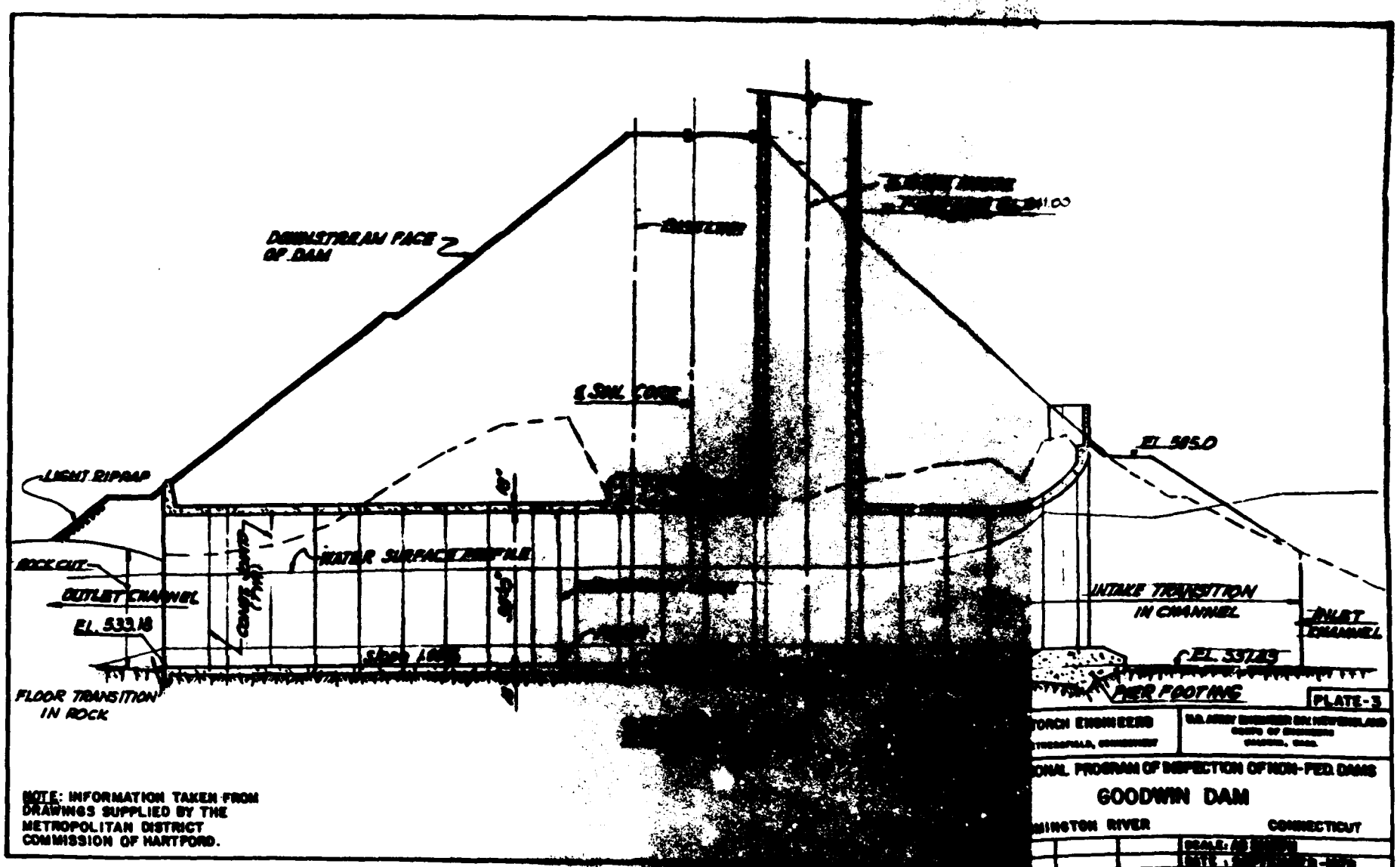
STORCH ENGINEERS

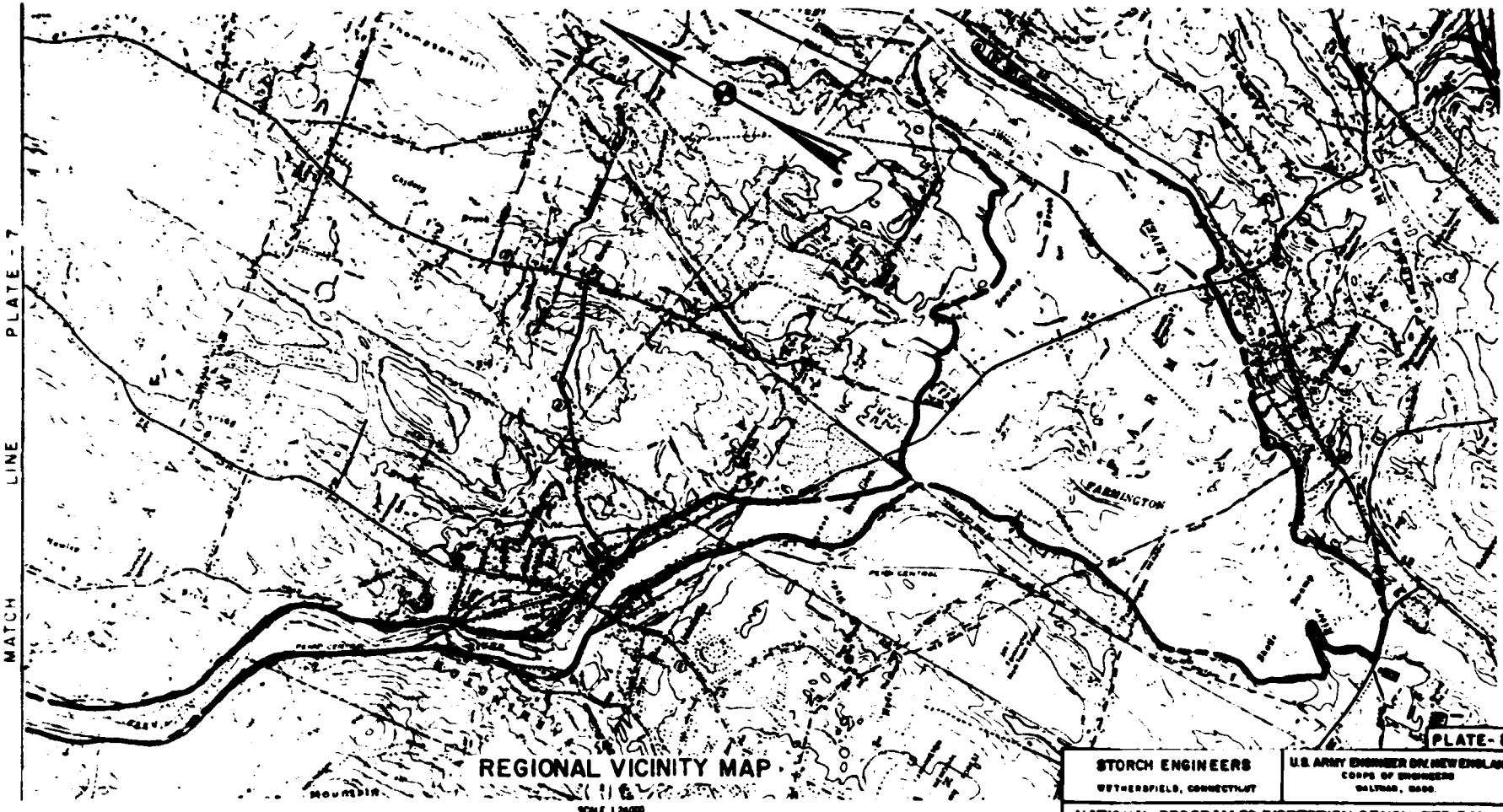
REGIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODWIN DAM

FARMINGTON RIVER

CONNECTICUT


DOWNSTREAM FACE OF DAM
LIGHT RIPRAP
ROCK CUT
OUTLET CHANNEL
EL. 533.18
FLOOR TRANSITION IN ROCK
WATER SURFACE PROFILE
EL. 585.0
INTAKE TRANSITION IN CHANNEL
INLET CHANNEL
EL. 537.25
PIER FOOTING
NOTE: INFORMATION TAKEN FROM DRAWINGS SUPPLIED BY THE METROPOLITAN DISTRICT COMMISSION OF HARTFORD.
PLATE-3
GOODWIN DAM
CONNECTICUT



REGIONAL VICINITY MAP

SCALE 1:24000

LEGEND

DENOTES LIMITS OF FLOODING IN CASE OF DAM FAILURE

CONTOUR INTERVAL 10 FEET

PLATE-8

STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

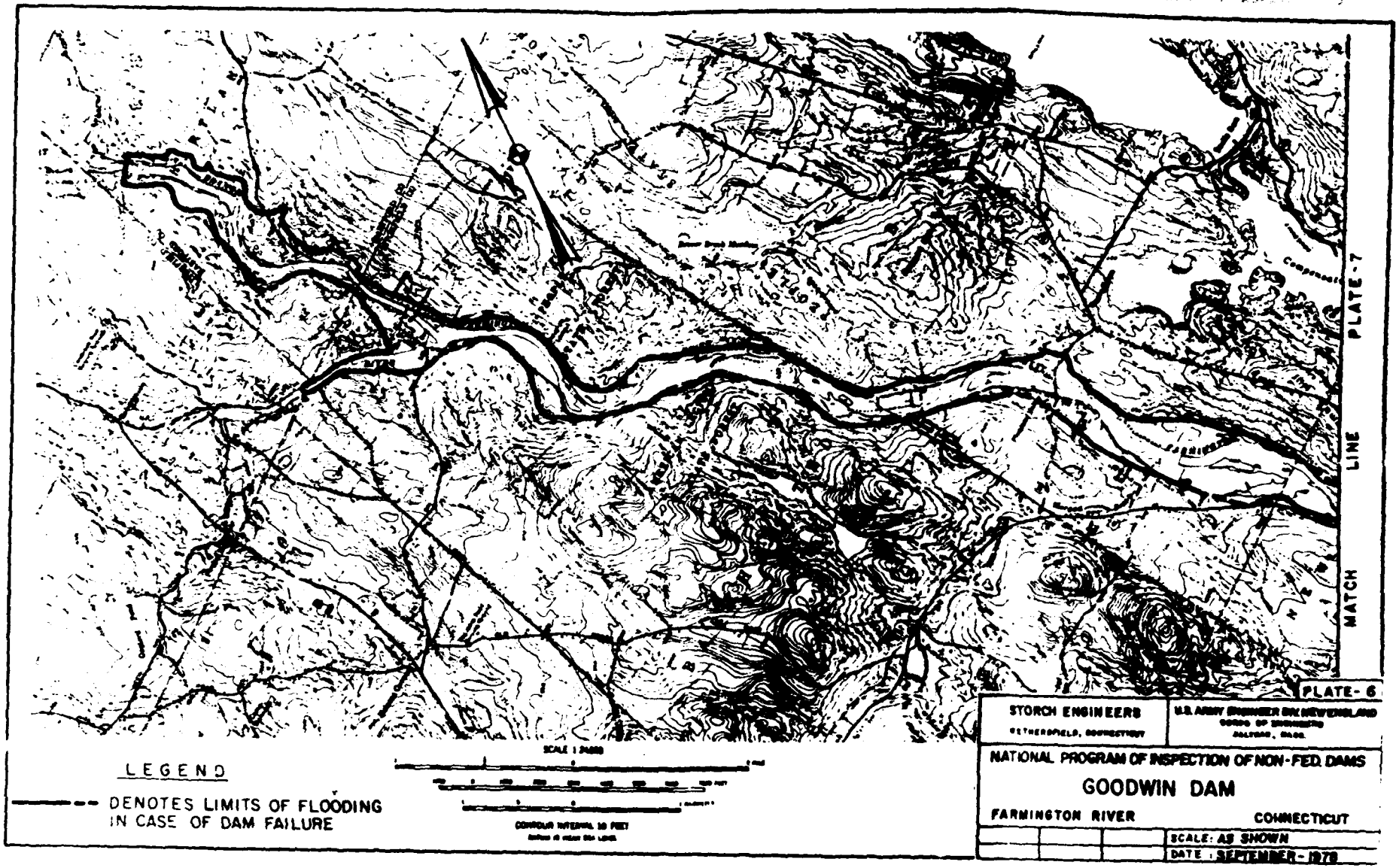
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GOODWIN DAM

FARMINGTON RIVER CONNECTICUT

SCALE: AS SHOWN

DATE: SEPTEMBER-1978


MATCH LINE PLATE-7
PLATE-6
LEGEND
DENOTES LIMITS OF FLOODING IN CASE OF DAM FAILURE
STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT
U.S. ARMY ENGINEER DIVISION NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
GOODWIN DAM
FARMINGTON RIVER
CONNECTICUT
SCALE: AS SHOWN
DATE : SEPTEMBER - 1978

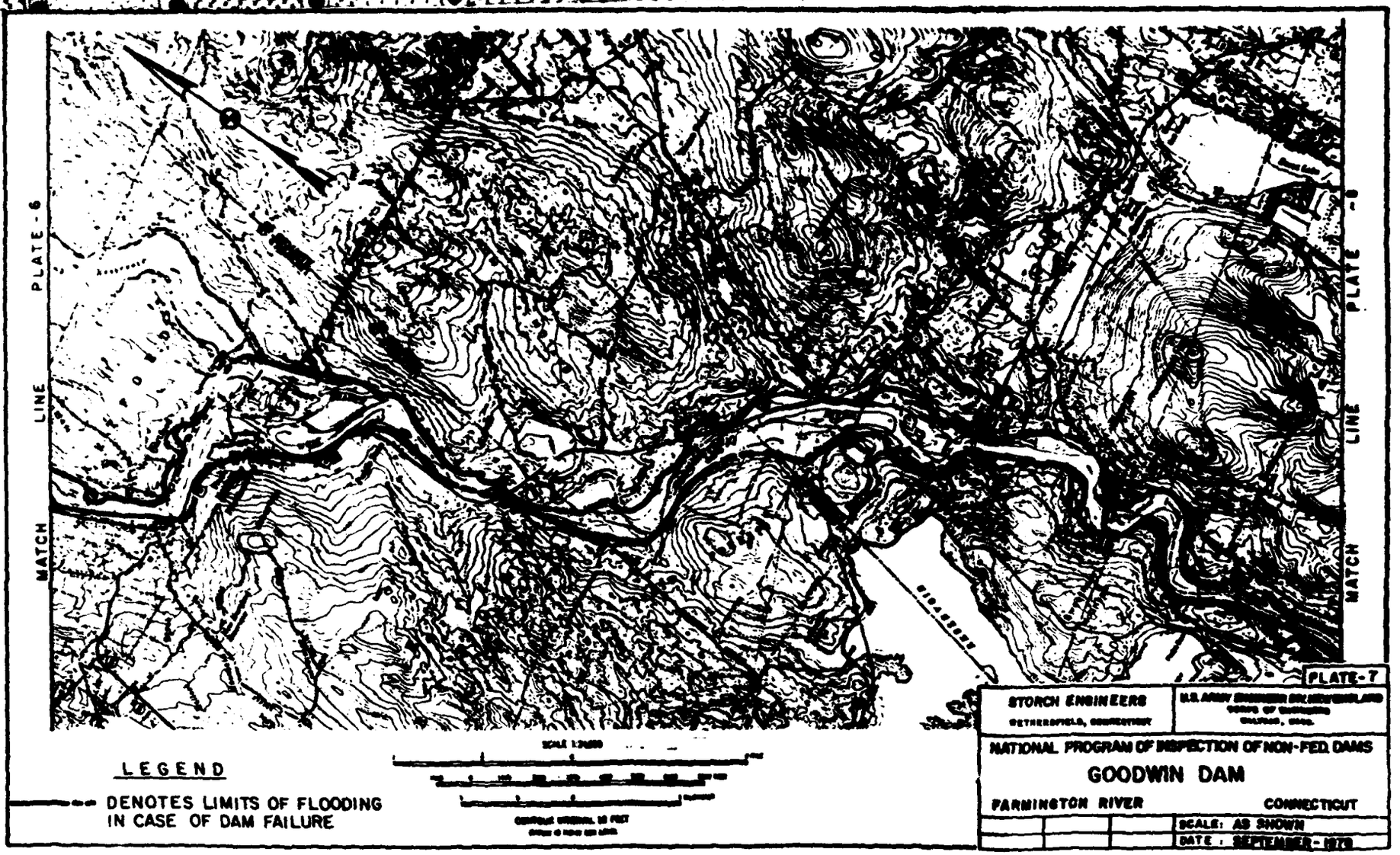


PLATE - 6
MATCH LINE
PLATE - 8
MATCH LINE
SIMSBURY
PLATE-7
STORCH ENGINEERS
WETHERSFIELD, CONNECTICUT
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.
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